USB Programmable, DIN Rail Mount
Thin Transmitter

Model TT234-0600, Two-Wire Transmitter
NTC Thermistor/Potentiometer/Rheostat Input
4-20mA Output

USER'S MANUAL

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8500-994E

Table of Contents

GETTING STARTED

DESCRIPTION 4

Key Features 4

Application 4

Mechanical Dimensions 5

DIN Rail Mounting & Removal 5

ELECTRICAL CONNECTIONS 6

Sensor Input Connections 7

Output/Power Connections 8

Earth Ground Connections 10

USB Connections 11

CONFIGURATION SOFTWARE 12

Quick Overview 12

OPERATION STEP-BY-STEP 14

Connections 14

Configuration 16

Calibration (Optional) 20

Thermistor Resistance versus Temperature 22

BLOCK DIAGRAM 23

How It Works 23

TROUBLESHOOTING 24

Diagnostics Table 24

Service & Repair Assistance 25

ACCESSORIES 26

Software Interface Package 26

USB Isolator 26

USB A-B Cable 26

USB A-mini B Cable 26

SPECIFICATIONS 27

Model Number 27

Input 27

Output 29

USB Interface 31

Enclosure & Physical 32

Environmental 32

Agency Approvals 33

Reliability Prediction 33

Configuration Controls 33

REVISION HISTORY 34

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IMPORTANT SAFETY CONSIDERATIONS

It is very important for the user to consider the possible adverse effects of power, wiring, component, sensor, or software failures in designing any type of control or monitoring system. This is especially important where economic property loss or human life is involved. It is important that the user employ satisfactory overall system design. It is agreed between the Buyer and Acromag, that this is the Buyer's responsibility.

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GETTING STARTED

DESCRIPTION

The TT234-0600 is an ANSI/ISA Type 2 transmitter designed to interface with thermistors and potentiometers/rheostats, isolate the input signal, and modulate a 4-20mA current signal to drive a two-wire current loop. Thermistor sensor excitation, linearization, and lead break or sensor burnout detection are supported. Configuration is performed using Windows software and a USB connection to Windows-based PC's (Windows XP and later versions only).

Key Features

- **Fully configurable via USB using Windows software.**
- **Thin 12.5mm wide enclosure for high-density DIN-rail mounting.**
- **High measurement accuracy and linearity.**
- **NTC Thermistors, Potentiometers, and Rheostats supported.**
- **User customizable Thermistor Linearization Table.**
- **Custom thermistor tables can be generated using Steinhart-Hart coefficients.**
- **Thermistor inputs are linearized with respect to temperature.**
- **Supports Celsius, Fahrenheit, and Kelvin temperature units.**
- **Up or down-scale lead-break/burnout detection.**
- **Adjustable input range and selectable output ranges.**
- **Input and output circuits are fully isolated from each other.**
- **Convenient two-wire loop power with non-polarized output connections.**
- **Normal or reverse acting output.**
- **Namur compliant loop current.**
- **Variable input filter adjustment.**
- **Wide-range DC power input from 12–32VDC.**
- **Wide ambient temperature operation.**
- **Thoroughly tested and hardened for harsh environments.**
- **CE Approved.**
- **UL/cUL Class1, Division 2 Approved.**

Application

For additional information on these devices and related topics, please visit our web site at www.acromag.com.

The TT234 transmitter is designed for high-density mounting on 35mm T-type DIN rails. Modules may be mounted side-by-side on 0.5 inch (12.5mm) centers.

This model interfaces with thermistor and potentiometer/rheostat inputs and isolates the input signal allowing it to mate with grounded or non-grounded input signals. It provides an output signal linearized to the thermistor sensor temperature. Optionally, it can support simple resistance input and drive an output signal linear with sensor resistance.

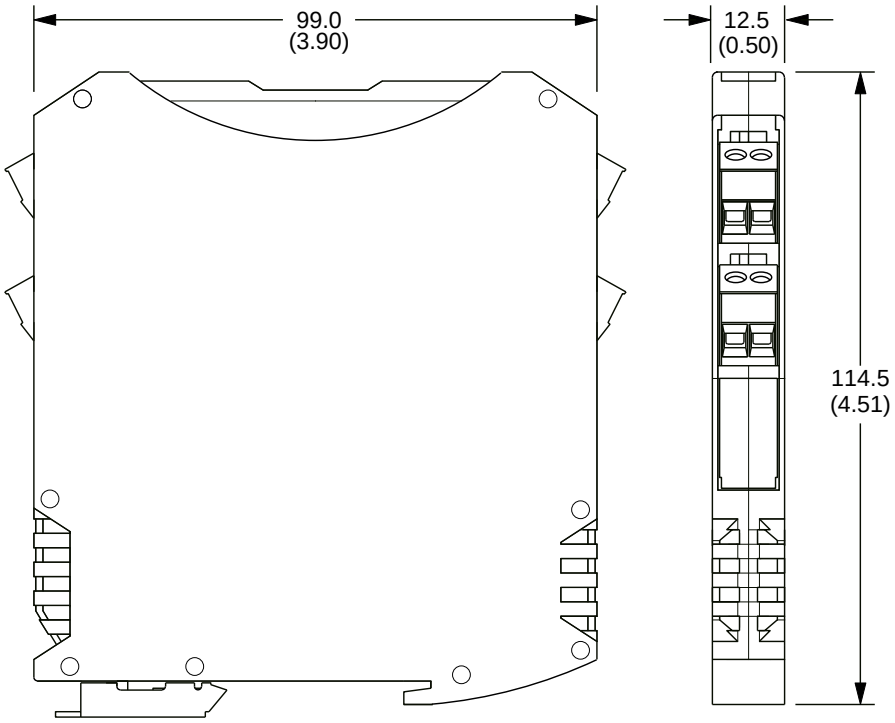
The output signal is transmitted via a two-wire, 4–20mA current loop. The two-wire current signal can be transmitted over long distances with high noise immunity. Its inherent live-zero 4mA offset current offers built-in output fault detection, should an output wire break. Extra connection screws at the output allow it to be optionally wired for a "sourced" 4–20mA output configuration (see Optional Output Wiring).

Mechanical Dimensions

Modules may be mounted to 35mm "T" type DIN rail (35mm, type EN50022), and side-by-side on 12.5mm (0.5-inch) centers.

NOTE:

IEC Safety Standards may require that this module be mounted within an approved metal enclosure or sub-system, particularly for applications with exposure to voltages greater than or equal to 75VDC or 50VAC.



DIMENSIONS ARE IN MILLIMETERS (INCHES)

DIN Rail Mounting & Removal

Refer to the following figure for mounting and removing a module from the DIN rail.

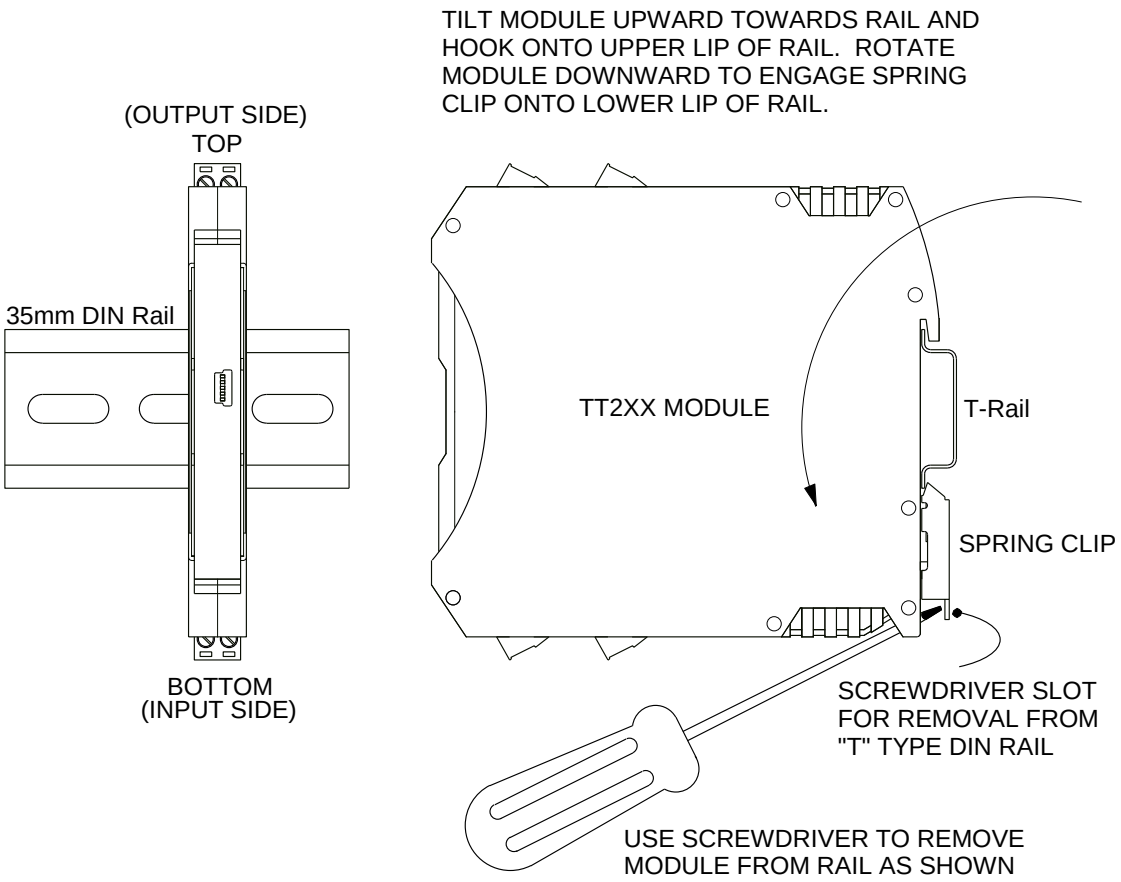
Mounting

A spring loaded DIN clip is located on the input side bottom. The rounded edge of the output side bottom allows the module to tilt upward so that it may be lifted from the rail when prying the spring clip back with a screwdriver. To attach a module to T-type DIN rail, angle the top of the module towards the rail and place the top groove of the module over the upper lip of the DIN rail. Firmly push the module downward towards the rail until it snaps into place.

Removal

To remove a module from the DIN rail, first separate the input terminal blocks from the bottom side of the module to create a clearance to the DIN mounting area. A screwdriver can be used to pry the pluggable terminals out of their sockets. While holding the module in place from above, insert a screwdriver into the lower path of the bottom of the module to the DIN rail clip and use it as a lever to force the DIN rail spring clip down while pulling the bottom of the module outward until it disengages from the rail. Tilt the module upward to lift it from the rail.

TT2XX MODULE DIN RAIL MOUNTING AND REMOVAL


TILT MODULE UPWARD TOWARDS RAIL AND HOOK ONTO UPPER LIP OF RAIL. ROTATE MODULE DOWNWARD TO ENGAGE SPRING CLIP ONTO LOWER LIP OF RAIL.
(OUTPUT SIDE)
TOP
35mm DIN Rail
BOTTOM
(INPUT SIDE)
TT2XX MODULE
T-Rail
SPRING CLIP
SCREWDRIVER SLOT FOR REMOVAL FROM "T" TYPE DIN RAIL
USE SCREWDRIVER TO REMOVE MODULE FROM RAIL AS SHOWN

ELECTRICAL CONNECTIONS

Wire terminals can accommodate 12–26 AWG solid or stranded wire. Input wiring may be shielded or unshielded type. Ideally, output wires should be twisted pair. Terminals are pluggable and can be removed from their sockets by prying outward from the top with a flat-head screwdriver blade.

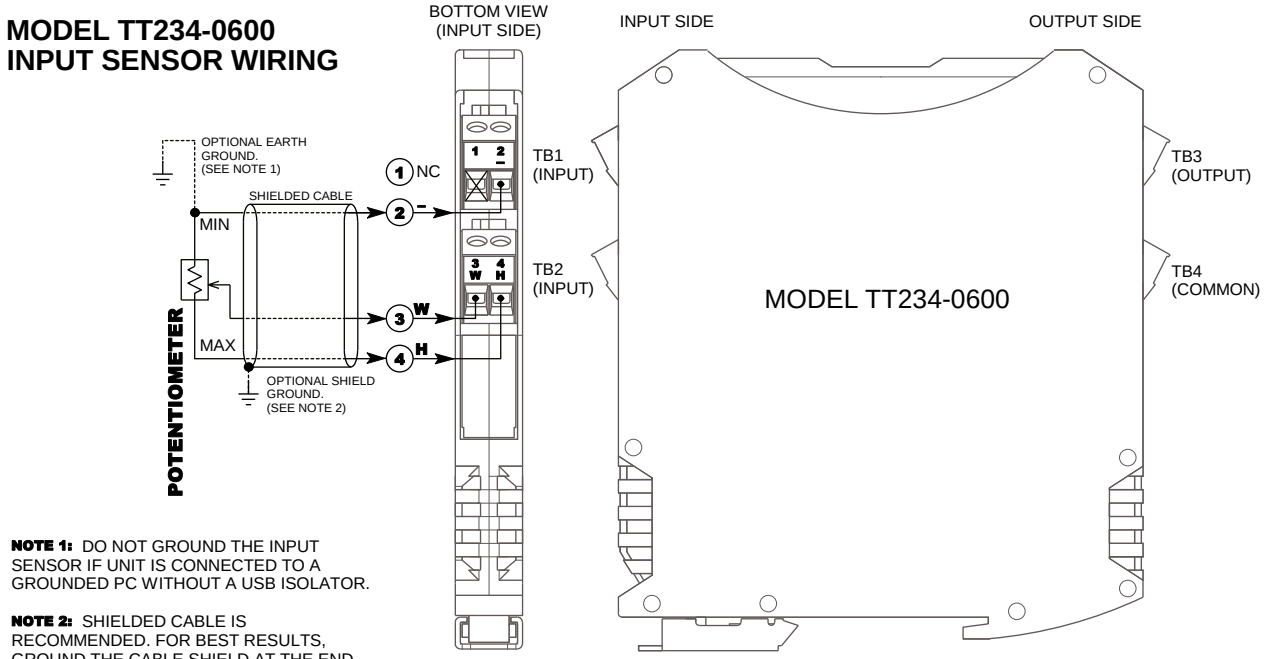
Strip back wire insulation 0.25-inch on each lead and insert the wire ends into the cage clamp connector of the terminal block. Use a screwdriver to tighten the screw by turning it in a clockwise direction to secure the wire (0.5-0.6Nm torque). Since common mode voltages can exist on signal wiring, adequate wire insulation should be used and proper wiring practices followed. As a rule, output wires are normally separated from input wiring for safety, as well as for low noise pickup.

Sensor Input Connections

Sensor wires are connected directly to the transmitter input terminals at the bottom of the transmitter (the spring-loaded DIN clip side), as shown in the connection drawing below.

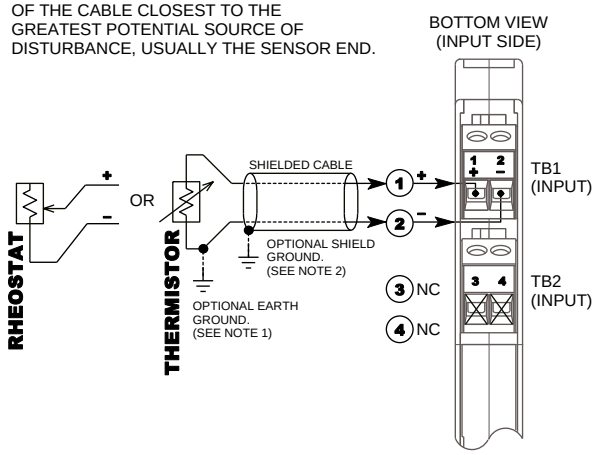
- **Transmitter Input Signal is Isolated from Output.**
- **Inputs are polarized.**
- **"+" and "–" connections for Thermistors and Rheostats can be swapped.**
- **"H" and "–" connections for Potentiometers can be swapped to reverse the direction of the input signal.**
- **Observe the wiper input "W" when connecting a Potentiometer.**
- **Only one input sensor may drive the output at one time.**
- **NOTE: Sensor lead-wire resistance will contribute an input shift for Thermistor and Rheostat input types. See Input Sensor Information below.**

MODEL TT234-0600
INPUT SENSOR WIRING



NOTE 1: DO NOT GROUND THE INPUT SENSOR IF UNIT IS CONNECTED TO A GROUNDED PC WITHOUT A USB ISOLATOR.

NOTE 2: SHIELDED CABLE IS RECOMMENDED. FOR BEST RESULTS, GROUND THE CABLE SHIELD AT THE END OF THE CABLE CLOSEST TO THE GREATEST POTENTIAL SOURCE OF DISTURBANCE, USUALLY THE SENSOR END.



INPUT SENSOR INFORMATION

POTENTIOMETER: A 3-WIRE VARIABLE RESISTOR USED TO FORM A VOLTAGE DIVIDER. VOLTAGE IS MEASURED RATIOMETRICALLY (AT WIPER LEAD) WITH RESPECT TO INPUT EXCITATION AND GROUND. VARIATIONS DUE TO SENSOR LEAD-WIRE RESISTANCE AND CHANGE IN RESISTANCE OVER TEMPERATURE ARE NULLIFIED BY USING A RATIOMETRIC MEASUREMENT TECHNIQUE.

THERMISTOR: A 2-WIRE SENSOR THAT VARIES RESISTANCE WITH SENSED TEMPERATURE. INPUT RESISTANCE FORMS A VOLTAGE DIVIDER WHICH IS USED TO CALCULATE THE SENSED TEMPERATURE BY COMPARING THE MEASURED RESISTANCE WITH KNOWN THERMISTOR CHARACTERISTICS. SENSOR LEAD-WIRE RESISTANCE WILL CONTRIBUTE A NEGATIVE SHIFT TO THE SENSOR MEASUREMENT.

RHEOSTAT: A 2-WIRE VARIABLE RESISTOR USED TO FORM A VOLTAGE DIVIDER. VOLTAGE IS MEASURED WITH RESPECT TO KNOWN INPUT IMPEDANCE (TOTAL RESISTANCE OF RHEOSTAT) IN ORDER TO CALCULATE THE SENSOR RESISTANCE. SENSOR LEAD-WIRE RESISTANCE WILL CONTRIBUTE A POSITIVE SHIFT TO THE SENSOR MEASUREMENT.

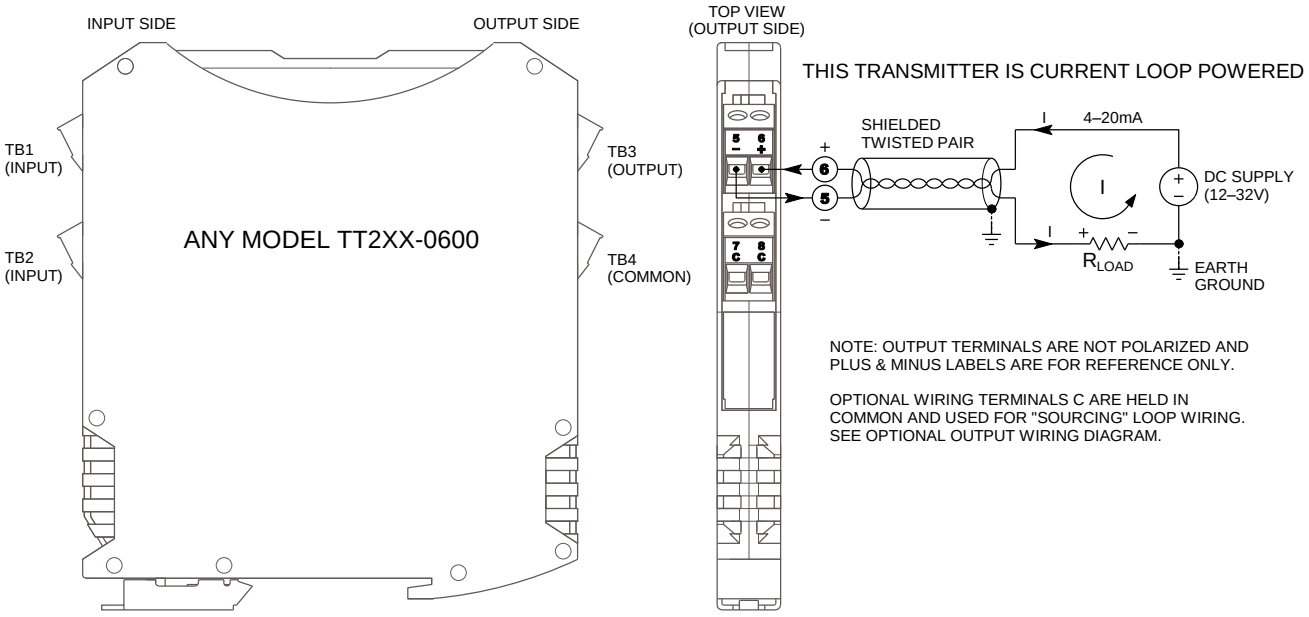
Output/Power Connections

Connect a DC power supply and load in series in the two-wire loop as shown in the drawing below. This transmitter has an ANSI/ISA Type II output in which the transmitter's power and output signal share the same two leads, and the transmitter output has a "floating" connection with respect to earth ground applied at the loop supply minus terminal.

- Output connections are not polarized. The output + and – designation are for reference only with current normally input to Output+ and returned via Output– (current-sinking).
- Loop supply voltage should be from 12–32VDC with the minimum voltage level adjusted to supply over-range current to the load, plus 11V MIN across the transmitter, plus any transmission line drop.
- Variations in power supply voltage between the minimum required and a maximum of 32VDC across transmitter, has negligible effect on transmitter accuracy.
- Variation in load resistance has negligible effect on output accuracy, as long as the loop supply voltage is set accordingly.
- Note the traditional placement of earth ground in the current loop. The transmitter output minus varies off this ground by the voltage drop in the load resistance and lead-wire.

MODEL TT2XX-0600 OUTPUT/POWER WIRING

TRADITIONAL LOOP-POWERED "SINKING OUTPUT" CONNECTIONS

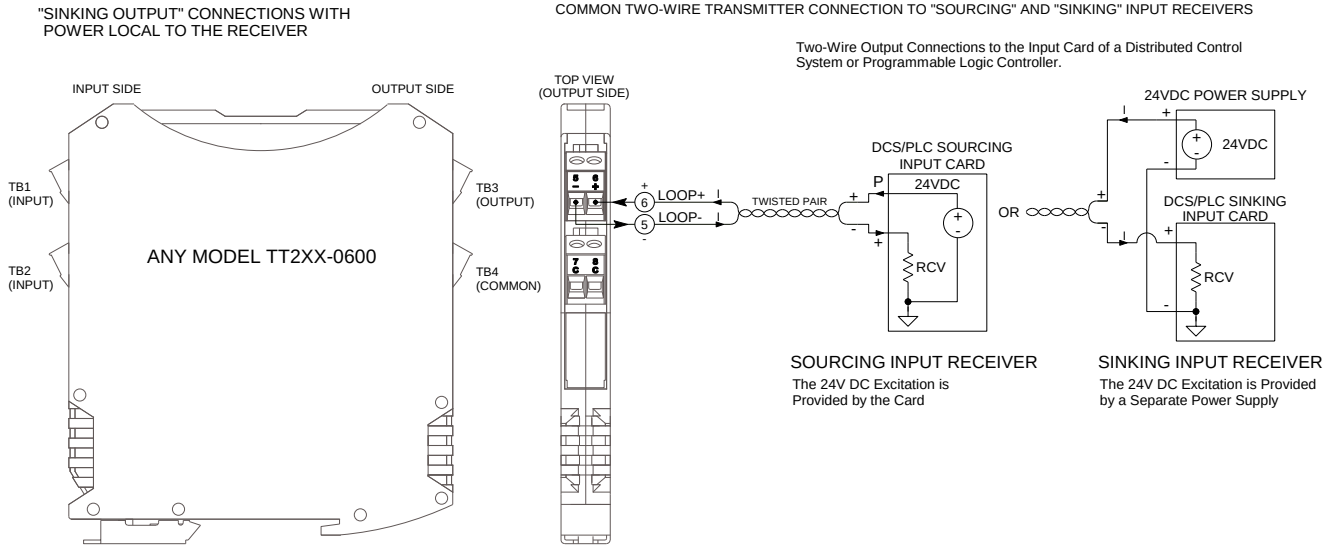

INPUT SIDE
OUTPUT SIDE
TB1 (INPUT)
TB2 (INPUT)
TB3 (OUTPUT)
TB4 (COMMON)
ANY MODEL TT2XX-0600
TOP VIEW (OUTPUT SIDE)
THIS TRANSMITTER IS CURRENT LOOP POWERED
SHIELDED TWISTED PAIR
4–20mA
DC SUPPLY (12–32V)
RLOAD
EARTH GROUND
NOTE: OUTPUT TERMINALS ARE NOT POLARIZED AND PLUS & MINUS LABELS ARE FOR REFERENCE ONLY.
OPTIONAL WIRING TERMINALS C ARE HELD IN COMMON AND USED FOR "SOURCING" LOOP WIRING. SEE OPTIONAL OUTPUT WIRING DIAGRAM.

The traditional loop-powered "sinking" output connections are shown above. Shielded twisted-pair wiring is often used at the output to connect the longest distance between the field transmitter and the remote receiver as shown. The output of this transmitter fluctuates relative to earth ground by the voltage drop in the load and connection wire. This makes it flexible in the way it connects to various "Receiver" devices.

Output/Power Connections...

In most installations, the loop power supply will be local to either the transmitter, or local to the remote receiver. Common receiver devices include the input channel of a Programmable Logic Controller (PLC), a Distributed Control System (DCS), or a panel meter. Some receivers already provide excitation for the transmitter loop and these are referred to as “sourcing” inputs. Other receivers that do not provide the excitation are referred to as “sinking” inputs, and these will require that a separate power supply connect within the loop. These types of receivers are depicted below.

MODEL TT2XX-0600 OUTPUT/POWER WIRING


"SINKING OUTPUT" CONNECTIONS WITH POWER LOCAL TO THE RECEIVER
INPUT SIDE
OUTPUT SIDE
TB1 (INPUT)
TB2 (INPUT)
TB3 (OUTPUT)
TB4 (COMMON)
ANY MODEL TT2XX-0600
TOP VIEW (OUTPUT SIDE)
LOOP+
LOOP-
COMMON TWO-WIRE TRANSMITTER CONNECTION TO "SOURCING" AND "SINKING" INPUT RECEIVERS
Two-Wire Output Connections to the Input Card of a Distributed Control System or Programmable Logic Controller.
TWISTED PAIR
DCS/PLC SOURCING INPUT CARD
24VDC
RCV
SOURCING INPUT RECEIVER
The 24V DC Excitation is Provided by the Card
OR
24VDC POWER SUPPLY
DCS/PLC SINKING INPUT CARD
SINKING INPUT RECEIVER
The 24V DC Excitation is Provided by a Separate Power Supply

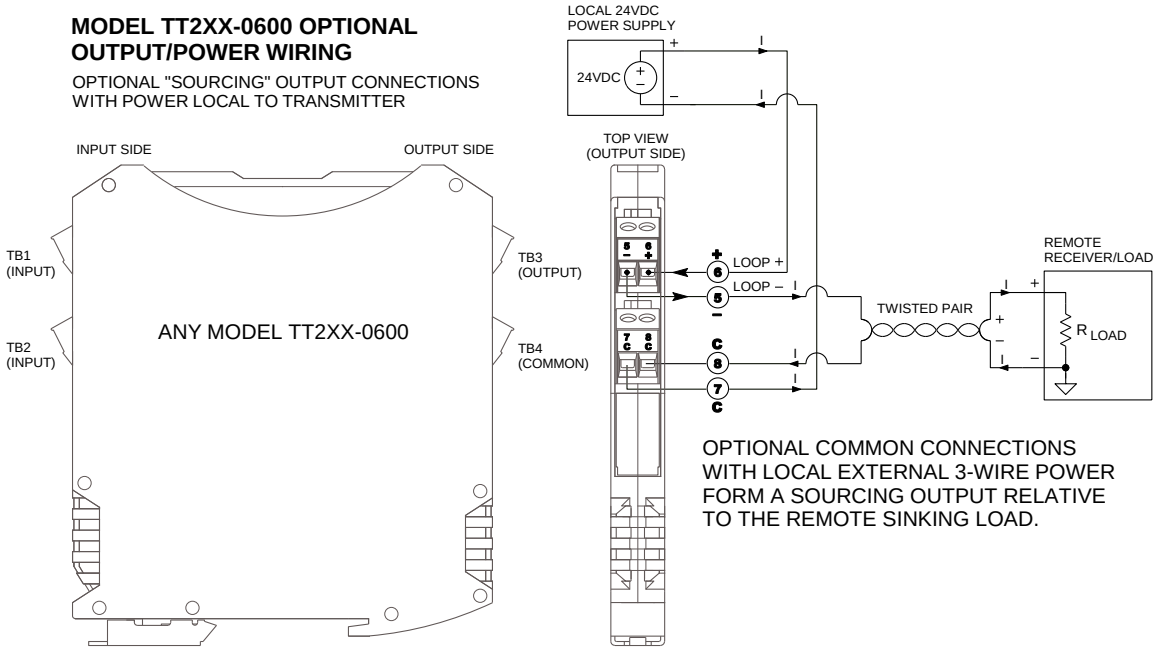
WARNING: For compliance to applicable safety and performance standards, the use of twisted pair output wiring is recommended. Failure to adhere to sound wiring and grounding practices as instructed may compromise safety, performance, and possibly damage the transmitter.

TIP – Ripple & Noise: Power supply ripple at 60Hz/120Hz is normally reduced at the load by the transmitter, but additional filtering at the load can reduce this ripple further. For large 60Hz supply ripple, connect an external 1uF or larger capacitor directly across the load to reduce excessive ripple. For sensitive applications with high-speed acquisition at the load, high frequency noise may be reduced significantly by placing a 0.1uF capacitor directly across the load, as close to the load as possible.

TIP – Inductive Loads: If the two-wire current loop includes a highly inductive load (such as an I/P current-to-pressure transducer), this may reduce output stability. In this case, place a 0.1uF capacitor directly across the inductive load and this will typically cure the problem.

Output/Power Connections...

This model includes two extra terminal connections at TB4 marked “C”, which provide a convenient wiring point for a “sourcing” wiring variation as shown below. Internally, these two terminals are connected in common with each other and do not connect to the internal circuit. Use of these terminals in the wiring scheme allows external power to be connected local to the transmitter and form a “sourcing” output entity from this “sinking” output as shown.



Earth Ground Connections

The transmitter housing is plastic and does not require an earth ground connection, except where the optional input cable shield is terminated on the transmitter If the transmitter is mounted in a metal enclosure, an earth ground wire connection to the metal enclosure’s ground terminal (green screw) is usually required using suitable wire per applicable codes. See the Electrical Connections Drawing for Output/Power connections and note the traditional position of earth ground for the two-wire output current loop. Earth ground is normally applied at the output loop power minus terminal and in common with the loop load or loop receiver minus. The Type II transmitter output terminals have a floating connection relative to earth ground and their potential varies with the voltage drop in the load and connection wire.

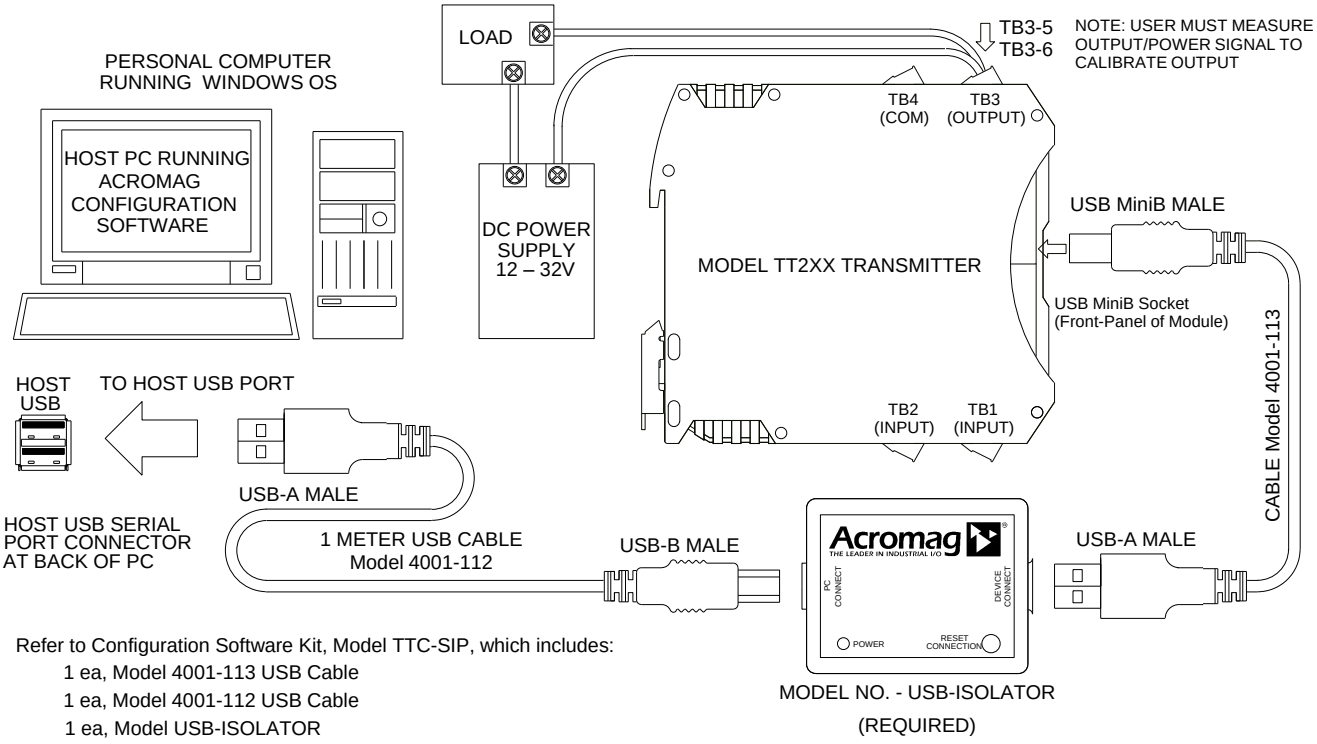
- Respect the traditional position of earth ground in a two-wire current loop and avoid inadvertent connections to earth ground at other points in the output circuit, which would drive ground loops and negatively affect operation. The input circuit is isolated and may additionally be earth grounded.
- A USB isolator is recommended when configuring or calibrating a transmitter to avoid the ground loop that occurs if the input sensor is also earth grounded (PC USB ports are commonly earth grounded and make contact with both the USB signal and shield ground which is held in common to the input circuit ground of the transmitter).

USB Connections

This transmitter is configured and calibrated via configuration software that runs on Windows-based PCs connected to the transmitter via USB (Windows XP or later version required). Refer to the following drawing to connect a PC to the transmitter for the purpose of configuration and calibration using this software.

TT SERIES USB TRANSMITTER CONNECTIONS

USED FOR CONFIGURATION AND CALIBRATION OF THE TRANSMITTER IN A SAFE OR ORDINARY LOCATION



Refer to Configuration Software Kit, Model TTC-SIP, which includes:

- 1 ea, Model 4001-113 USB Cable
- 1 ea, Model 4001-112 USB Cable
- 1 ea, Model USB-ISOLATOR
- 1 ea, Configuration Software CDROM 5040-944

WARNING:

The intent of mating USB with this transmitter is so that it can be conveniently configured and calibrated in a safe area, then installed in the field which may be in a hazardous area. Do not attempt to connect a PC or laptop to this transmitter while installed in a hazardous area, as USB energy levels could ignite explosive gases or particles in the air.

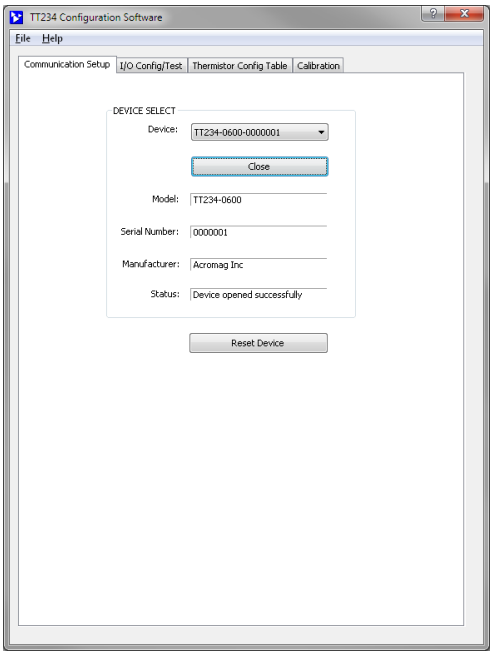
- **USB Signal Isolation is Required (See Below) –** Acromag model USB-ISOLATOR may be used to isolate the USB port, or optionally, another USB signal isolator that supports USB Full Speed operation (12Mbps).
- **Configuration Requires USB and Loop Power –** This transmitter draws power from both the current loop and from USB during setup.

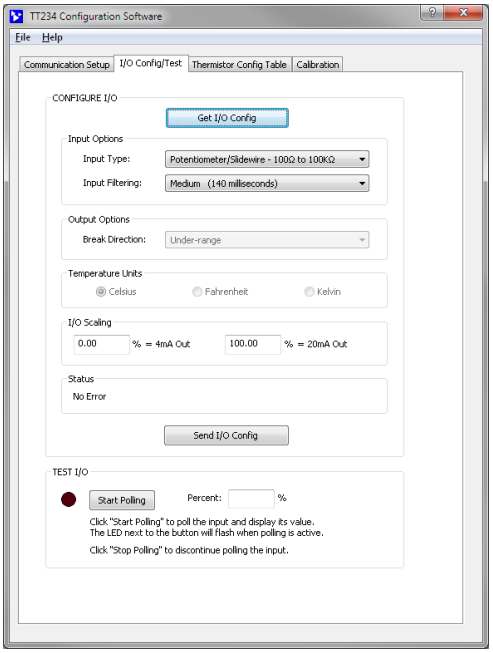
IMPORTANT: USB logic signals to the transmitter are referenced to the potential of the transmitter's input ground. This ground is held in common with USB ground and USB cable shield ground. The potential of the transmitter's current output pin (output minus) relative to earth ground will vary according to the load current and load resistance (net IR drop). Without isolation, this IR drop would drive a potential difference between the normally grounded current loop and the grounded USB connection at the PC, causing a ground loop that would inhibit setup and calibration, and may even damage the transmitter. This is why an isolated USB connection is recommended. The use of an isolator can be avoided if a battery powered laptop PC is used to connect to the transmitter, and the laptop has no other earth ground connection, either directly or via a connected peripheral.

CONFIGURATION SOFTWARE

Quick Overview

*Click **"Open"** to connect to the TT234-0600 and the software will look similar to the following:*





This transmitter can only be configured and calibrated via its configuration software and a USB connection to a PC or laptop. The configuration software is contained in a zip file that can be downloaded free of charge from our web site at www.acromag.com. If you do not yet have a user account, you will need to create one before the download becomes accessible. The zip file will extract to an executable file which installs software to the "/Program Files/Acromag" directory on your computer. Note: You need administrator privileges on the PC you wish to install this software. Once installed, navigate to the "/Program Files/Acromag" directory and open the correct software for your particular model. This software is also included on a CDROM bundled with the Configuration Kit TTC-SIP (see Accessories). For this transmitter, use the software named "**TT234 Config.exe**".

Communication Setup (First Connect to Transmitter Here)

- Select from connected transmitters and Open/Close communication with them.
- Display the Model, Serial Number, and Manufacturer of the connected transmitter and report the status of communication.

I/O Config/Test (Configure and/or Test the Transmitter Here)

- Optional - Click the **[Get I/O Config]** button to retrieve the I/O configuration of the currently connected transmitter.
- Select the Input Type: Potentiometer/Slidewire, Thermistor, or Rheostat.
- Select the level of digital filtering: High, Medium, Low or None. The corresponding I/O response times are listed in parenthesis next to the filter selection.
- Select the Break Direction: Under-range or Over-range, if applicable.
- Select the temperature units to use in the I/O Configuration, if applicable.
- Enter the I/O Scaling. Specify the input temperatures or percentages to correspond to Zero-Scale and Full-Scale.
- Submit the configuration settings to the transmitter by clicking the **[Send I/O Config]** button to write the settings to the non-volatile EEPROM memory.

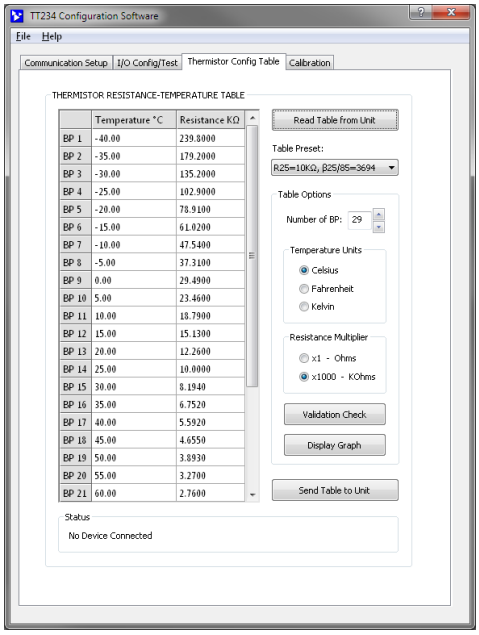
I/O Test (Optional, Verify Transmitter Operation Here)

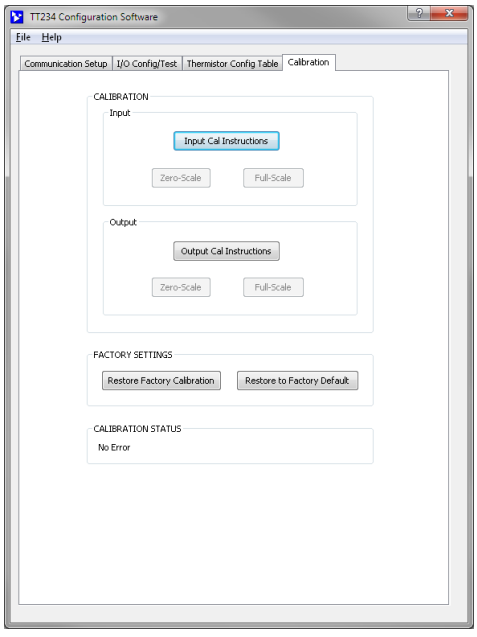
After making I/O configuration changes, you can use the I/O Test controls to start/stop polling the input channel to check your input readings.

Click "Start Polling" to periodically read your input channel and validate its operation. Click "Stop Polling" to stop polling the input channel. Note the simulated red lamp next to the button flashes slowly when the software is polling the input channel.

For detailed configuration and calibration procedures, see the Operation Step-By-Step section of the Technical Reference of this manual on Page 14.

Quick Overview...





HELP:

You can press **[F1]** for Help on a selected or highlighted field or control. You can also click the **[?]** button in the upper-right hand corner of the window and click to point to a field or control to get a Help message pertaining to the item you pointed to.

Thermistor Config Table – For Thermistor Input Types Only (Define the Thermistor Characteristics Here)

- Optional - Click the **[Read Table from Unit]** button to retrieve the Thermistor table stored on the currently connected transmitter.
- Select the Table Preset. Templates will automatically fill out the temperature column.
- Set the number of Break-points, i.e. the number of rows in the Thermistor table.
- Select the temperature units to use in the Thermistor Config Table.
- Select the resistance multiplier. This determines if the Thermistor Config Table resistance is in Ohms or Kilohms.
- Click the **[Validation Check]** button to have the configuration software check the Thermistor table breakpoints for extraneous or erroneous values. Breakpoints that need attention are highlighted.
- Submit the Thermistor table to the transmitter by clicking the **[Send Table to Unit]** button to write the table to the non-volatile EEPROM memory.

CALIBRATION (Calibrate the Input and/or Output if Needed)

This transmitter has already been factory calibrated. If you encounter excessive error, you can click the Calibration tab to display the Calibration control page as shown at left.

To calibrate the Input or Output stage of this transmitter, simply click the respective “Cal Instructions” button and follow the prompts.

Input…

Click the **[Input Cal Instructions]** button to begin input calibration. When you click **[Zero-Scale]** or **[Full-Scale]** of the Input Calibration section, you will be prompted to connect input pins together or apply a specific resistance at the input terminals. Once you have applied this resistance or connected the correct input pins, click the **[OK]** button of the prompt to calibrate the input.

Output…

Click the **[Output Cal Instructions]** button to begin output calibration. When you click **[Zero-Scale]** or **[Full-Scale]** of the Output Calibration section, you will be prompted to measure the output signal and enter the measurements in the field provided. Click the **[Submit Measurement]** button to calibrate the output.

Factory Settings (Use only in case of trouble or for sanitation purposes)

- Restore a transmitter to its original factory calibration
- Restore a transmitter to its initial factory configuration

You can click the **[Restore Factory]** buttons if you ever misconfigure or miscalibrate a transmitter in such a way that its operation appears erratic.

Calibration Status (Bottom of Window)

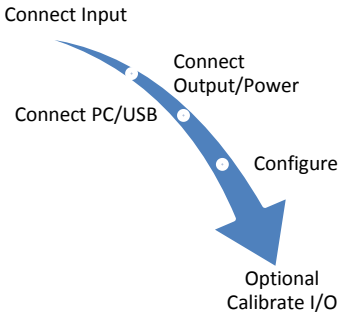
The Calibration Status bar at the bottom of the window will display status messages relative to calibration over USB.

TECHNICAL REFERENCE

OPERATION STEP-BY-STEP

Connections

This section will walk you through the Connection–Configuration–Calibration process step-by-step. Before attempting to reconfigure or recalibrate this transmitter, verify the following electrical connections:



Calibration Connections:

NOTE: When calibrating, the input source, output meter, and load resistor (for current output) must be accurate beyond the transmitter specifications, or better than ±0.1%. As a general rule, calibration equipment accuracy should be four times better than the rated accuracy you are trying to achieve with this transmitter.

Connect Input: Connect a precision resistance decade box to the input at for Thermistors and Rheostats, or at TB1 with pins 2 unused and TB2 for Potentiometers (refer to Sensor Input Connections). The resistance source must be adjustable over the range desired for zero and full-scale.

Calibration & Configuration Connections:

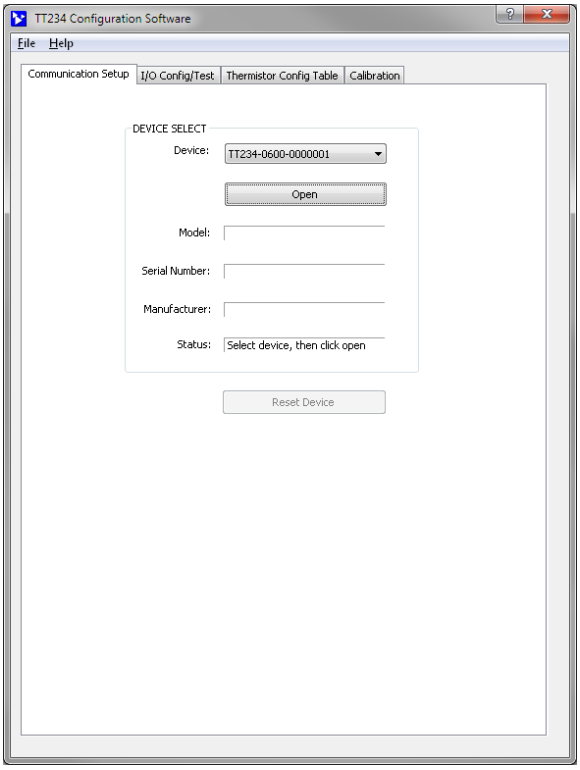
Connect Output/Power: Refer to Output/Power Connection section and wire an output current loop to the transmitter as illustrated. You will need to measure the output current accurately in order to calibrate the transmitter. You can connect a current meter in series in this loop to read the loop current directly (not recommended). Alternatively, you could simply connect a voltmeter across a series connected precision load resistor in the loop, and accurately read the output current as a function of the IR voltage drop produced in this resistor (recommended). In any case, be sure to power the loop with a voltage that is minimally greater than the 11V required by the transmitter, plus the IR drop of the wiring and terminals, plus the IR drop in the load. To computer the IR drop, be sure to use a current level that considers the over-scale current (up to 24mA).

Loop Power Supply Voltage: Make sure your voltage level is at least 11V plus 0.020*load_resistance. Ideally, it should be great enough to drive the 24mA over-range current into your load (i.e. up to 11V+ 0.024*Rload, assuming line drop is negligible and the maximum possible over-range is considered). Always apply power to the transmitter output loop even when connected to USB.

Connect to PC via USB: Refer to USB Connections section and connect the transmitter to the PC using the USB isolator and cables provided in the Configuration Kit TT-SIP.

Now that you have made your connections and applied power to your loop, you can execute the “TT234 Config.exe” software to begin configuration of the transmitter (software is compatible with XP or later versions of the Windows operating system).

Connections...

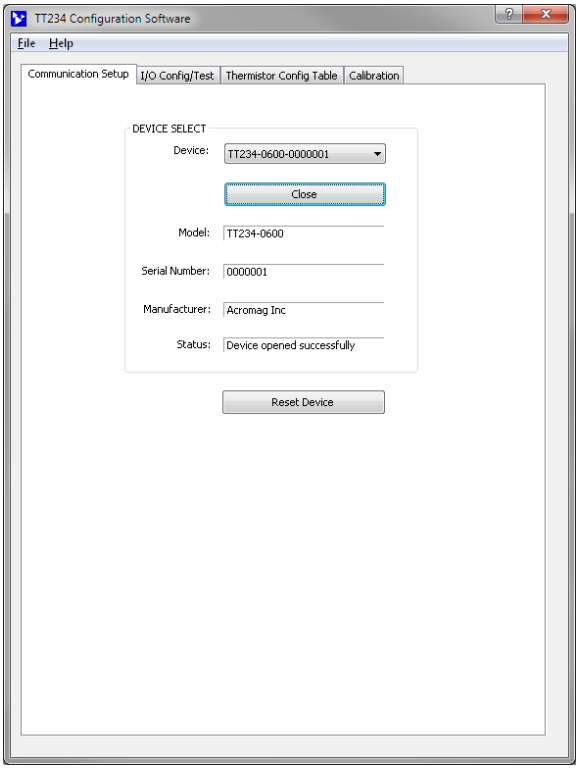


NOTE: You should already have power connected to the transmitter. You will not be able to calibrate, or test the transmitter without power applied.

After executing the Acromag Configuration software for this transmitter, the window shown at left will appear, if you have not already connected to the transmitter via USB (note fields are blank under these conditions).

Connect your PC to the transmitter via USB, and the transmitter's model-serial information will appear in the device field as shown in the second window at left.

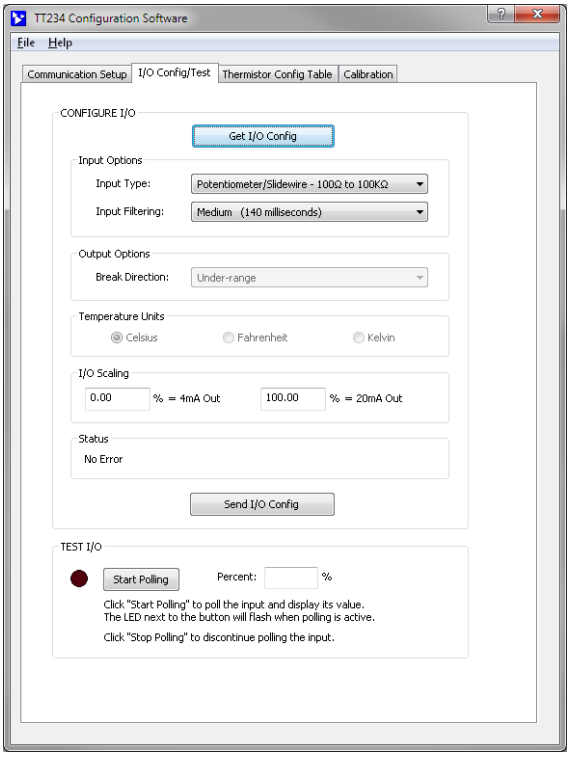
If you happen to be connected to more than one transmitter via a USB hub, you can use the device scroll field to select another transmitter, using the serial information suffix of the model number to discern one transmitter from another.



Select a transmitter from the drop down menu. When you click on a transmitter name from the drop down menu, the software will automatically attempt to open a connection with the selected transmitter. If the software does not have an open connection with the transmitter, click the **[Open]** button to open a connection with the transmitter.

After opening a connection to a transmitter, the transmitter's Model, Serial Number, Manufacturer, and connection status will be displayed as shown in the image on the left. In addition, the Status field will indicate "Device opened successfully" as shown in the image at left.

Configuration



HELP:

You can press **[F1]** for Help on a selected or highlighted field or control. You can also click the **[?]** button in the upper-right hand corner of the window and click on a field or control to get a Help message pertaining to the item you clicked on.

At this point, you can click the **"I/O Config/Test"** tab to begin configuring the transmitter, or to optionally test its operation. The I/O Config/Test window is the image shown at left.

When you click the "I/O Config/Test" tab, the software retrieves the transmitter's current configuration and displays it similar to the image shown at left.

If you are connected to a transmitter, the initial I/O Config page represents the current configuration of the connected transmitter before making changes. Otherwise, if you have loaded the configuration from a saved a file, or if you have made changes to any fields, you can click the **[Get I/O Config]** button to retrieve the transmitter's current configuration.

NOTE: If you make any changes to the selections indicated, the only way to preserve your changes is to write them to the transmitter by clicking the **[Send I/O Config]** button after completing your selections, or save them to a file by opening the **"File"** menu in the upper left-hand corner of the window.

Select the Input Type...

- If you select **"Thermistor"**, the output will be linear with respect to the sensor temperature.
- If you select **"Potentiometer/Slidewire"**, the output will be linear with respect to the percent of input span, not temperature, and no special linearization will be performed.
- If you select **"Rheostat"**, the output will be linear with respect to the input resistance, not temperature, and no special linearization will be performed.

Select the Input Filtering...

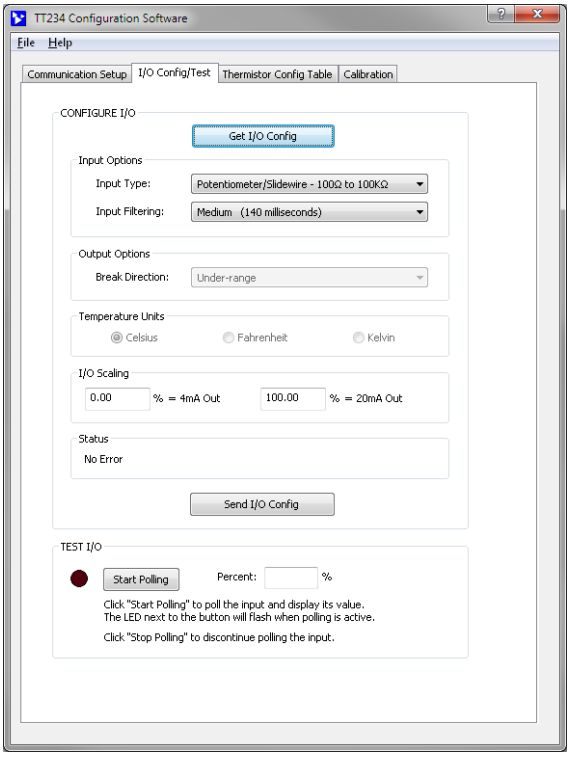
You may select the level of digital filtering to apply to the input channel as None, Low, Medium, or High. The respective I/O response times are indicated in parenthesis next to the filter selection. Note that higher filter levels results in lower average noise, but with slower I/O response times.

Select the Break Direction...

Upon sensor burnout or a broken sensor lead, you can select **"Under-range"** to send the output to its under-range limit, or **"Over-range"** to send the output to the over-range limit. Note that outputs can be reverse acting, but in the case, under-range and over-range remain normal. Under-range and over-range limits are 5% outside the nominal output range selected.

NOTE: Potentiometer input types do not support break direction.

Configuration...



HELP:

You can press **[F1]** for Help on a selected or highlighted field or control. You can also click the **[?]** button in the upper-right hand corner of the window and click on a field or control to get a Help message pertaining to the item you clicked on.

NOTE:

A 5% under-range and over-range capability is built into the output range by design. See Output Specifications for more detail.

Select the Temperature Units...

Select the temperature units to use in the I/O Configuration. You may select Celsius, Fahrenheit, or Kelvin.

Enter the I/O Scaling values...

You may rescale the input range to use only a portion of the input range to drive the output if desired. Be careful not to reduce the input range too much, as resolution will be proportionally diminished and noise/error magnified.

In the corresponding I/O Scaling field, enter the input signal minimum/zero value to correspond to the output range Zero-Scale value (i.e. 4mA). Also set the input range Full-Scale (i.e. 20mA). You can optionally swap I/O Scaling values to configure a reverse acting output response if desired. Note: Approximately 5% under-range and over-range is built into the output range.

If the I/O Scaling Zero-Scale and Full-Scale points are chosen too close together, performance will be degraded.

Submit I/O Configurations

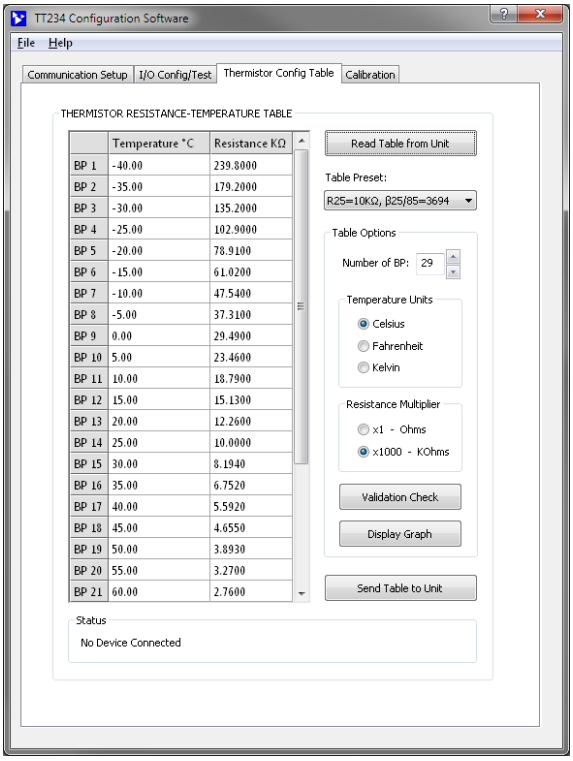
Once you have made your configuration selections, click the **[Send I/O Config]** button to write them to the transmitter. You can read the status of your sent message in the "Status" field. Alternately, you could click **"File"** in the upper left-hand corner to save the configuration settings to a file on your PC for later reference.

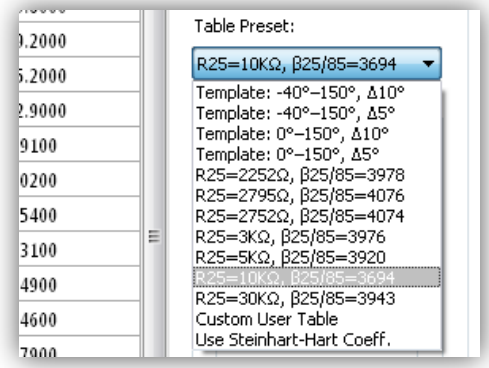
At this point, you can test the transmitter's operation by clicking on the **[Start Polling]** button of the TEST I/O Section of the page to trigger the software to periodically read the input and display its value in the field to the right of the polling toggle button. Note the simulated lamp next to the button flashes each time the input is sampled. Click **[Stop Polling]** to stop polling the input.

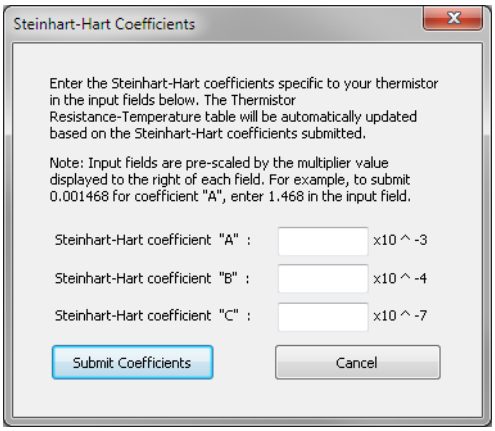
Thermistor Config Table (Thermistor Input Types Only)

If the transmitter will be interfacing with a thermistor, the Thermistor Config Table needs to be updated and/or verified. Proceed to the next section for instructions on this process.

Configuration...






Steinhart-Hart Coefficients
Enter the Steinhart-Hart coefficients specific to your thermistor in the input fields below. The Thermistor Resistance-Temperature table will be automatically updated based on the Steinhart-Hart coefficients submitted.
Note: Input fields are pre-scaled by the multiplier value displayed to the right of each field. For example, to submit 0.001468 for coefficient "A", enter 1.468 in the input field.
Steinhart-Hart coefficient "A" :
x10 ^ -3
Steinhart-Hart coefficient "B" :
x10 ^ -4
Steinhart-Hart coefficient "C" :
x10 ^ -7
Submit Coefficients
Cancel

Click the **"Thermistor Config Table"** tab to begin configuring the thermistor table. After clicking this tab, the software retrieves the connected transmitter's current thermistor table configuration and displays it similar to the image shown at left.

If you are connected to a transmitter, the initial Thermistor Config Table page represents the current thermistor table configuration of the connected transmitter before making changes. Otherwise, if you have loaded the configuration from a saved a file, or if you have made changes to any fields, you can click the **[Read Table from Unit]** button to retrieve the transmitter's current thermistor table configuration.

NOTE: If you make any changes to the table or selections indicated, the only way to preserve your changes is to write them to the transmitter by clicking the **[Send Table to Unit]** button after completing your changes, or save them to a file by opening the **"File"** menu in the upper left-hand corner of the window.

(Optional) Select the Table Preset...

Selecting a preset loads the Thermistor Table with sample values based on popular thermistor sensors. See **"Thermistor Resistance versus Temperature"** section of this manual for notes on calculating beta (β). Template presets automatically fill out the temperature column and space the break-points by the degrees delta (Δ) listed in the preset name.

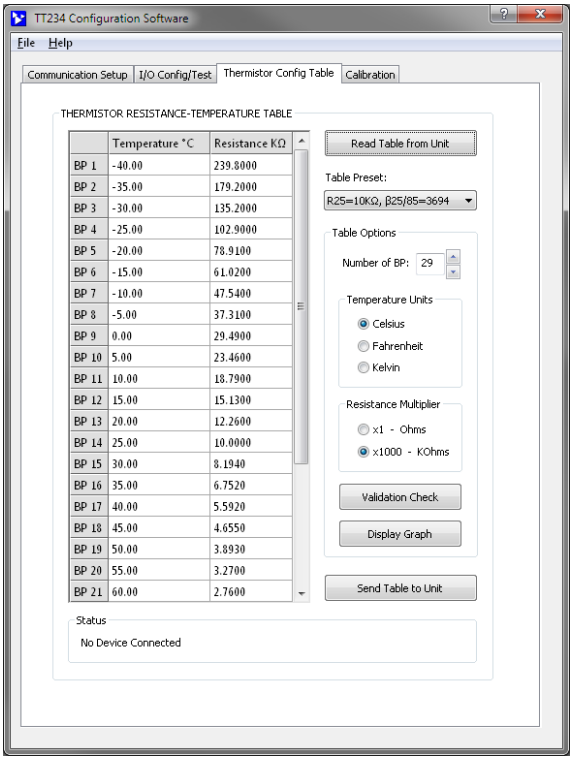
NOTE: Whenever you modify the Thermistor Table, the **Table Preset** will automatically change to Custom to indicate that the table is no longer identical to a selectable preset.

Using Steinhart-Hart coefficients:

NTC Thermistors can be modeled using the Steinhart-Hart equation. This equation uses 3 coefficients to generate a resistance-temperature curve which relates the thermistor resistance to the sensed temperature. To assist the generation of break-points for the thermistor table, the Configuration Software provides a method for entering 3 Steinhart-Hart coefficients. Select **"Use Steinhart-Hart Coeff."** from the **Table Preset** drop-down menu to open the Steinhart-Hart Coefficients prompt.

The Steinhart-Hart Coefficients prompt contains three input fields, one for each Steinhart-Hart coefficient. Enter the coefficients for your NTC thermistor in the appropriate input fields. Notice that each field is already multiplied by a constant value. For example, the input field for coefficient "A" is multiplied by 10^{-3}. Therefore, to submit 0.001468 for coefficient "A", enter 1.468 in the corresponding input field. After all 3 Steinhart-Hart coefficients have been entered, click **"Submit Coefficients"**. The Configuration Software will then generate a custom Thermistor Resistance-Temperature table using the Steinhart-Hart equation and the coefficients submitted.

Configuration...



HELP:

You can press **[F1]** for Help on a selected or highlighted field or control. You can also click the **[?]** button in the upper-right hand corner of the window and click on a field or control to get a Help message pertaining to the item you clicked on.

Validation Color Key:

Color	Indication
Red	The break-point contains a duplicate temperature, duplicate resistance, invalid temperature, zero resistance, or the resistance does not decrease with increasing temperature. Fix the break-point to proceed.
Green	Linear regression was performed on this break-point instead of logarithmic regression. The break-point is still valid and will be included in the internal representation.

Enter the Number of Break-points...

You can control the number of break-points (i.e. rows) in the Thermistor table by changing this value. The number of break-points is limited to a minimum of 3 and a maximum of 50.

NOTE: More break-points allow the software to generate a more accurate internal representation of the thermistor over the ranges that the break-points characterize.

Select the Temperature Units...

Select the temperature units to use in the Thermistor Config Table. You may select Celsius, Fahrenheit, or Kelvin. The table will automatically convert the temperature column from the previous temperature to the selected temperature.

Select the Resistance Multiplier...

Select the resistance multiplier. You may select x1 - Ohms or x1000 - Kilohms. The table will automatically convert the resistance column from the previous resistance to the selected resistance

Editing the Thermistor Table:

The configuration software maintains a table that allows you to characterize the thermistor sensor that the transmitter will interface with. When you enter break-points into the Thermistor Table, you are providing known values of the thermistor's resistance with respect to the temperature sensed. These values are then used by the software to generate an internal representation (piece-wise linear) of the thermistor that can be used by the transmitter.

Click on a cell to select it. When a cell is selected, you can modify its value by typing a number on the keyboard. To save the value typed into the cell, hit the enter key, or advance the selection to a different cell. You may select a range of cells using the mouse cursor.

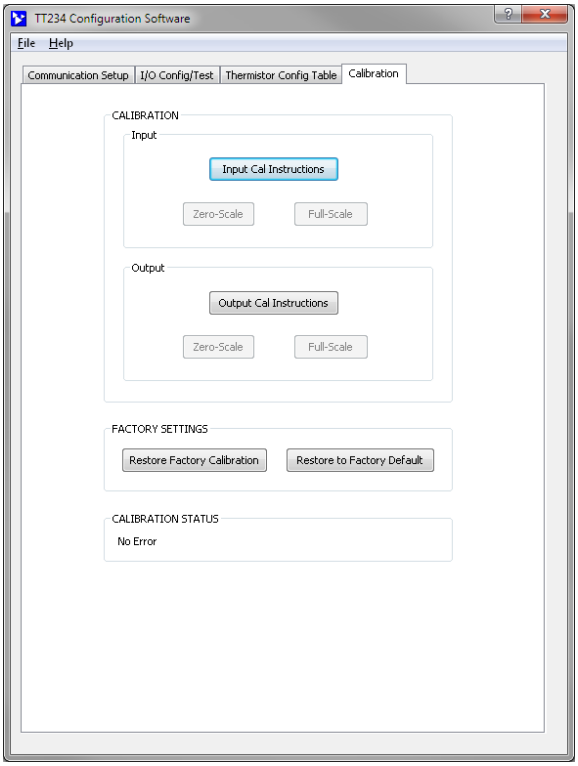
Break-points should characterize the thermistor over its range of application. Using more break-points will allow the software to calculate a more accurate internal representation.

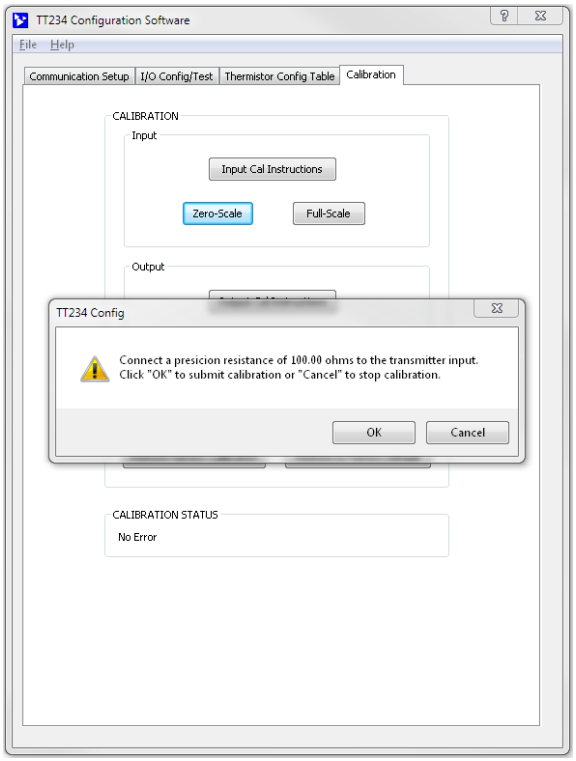
NOTE: It is not necessary to enter the break-points such that they are in ascending or descending order of value. The software automatically sorts the break-points internally.

Validation Check...

Click the **[Validation Check]** button to have the software check the break-points in the Thermistor Table for erroneous or extraneous values. Break-points that are flagged will be highlighted using the color scheme detailed in the Validation Color Key on the left.

Calibration (Optional)





Submit Thermistor Configuration Table

Once you have made the changes to the Thermistor Config Table, click the **[Send Table to Unit]** button to write them to the transmitter. The Thermistor Config Table page will be disabled during the transfer. You can read the status of the transfer in the "Status" field. Alternately, you could click **"File"** in the upper left-hand corner to save the configuration settings to a file on your PC for later reference.

Once you've configured the transmitter, you are ready to install it in the field, as the transmitter has already been factory calibrated. If you later encounter error that is out of specification, you can click the **"Calibration"** tab to display the Calibration control page shown at left.

IMPORTANT: This transmitter has already had its input and output channels factory calibrated with a high level of precision. If you attempt to recalibrate the input or output channel, you could degrade its performance if it is not completed properly, or it is done using lower grade equipment. Consider your decision to recalibrate carefully.

Calibration – Input

Before attempting to recalibrate the input channel, make sure the selected Input Type on the "I/O Config" page is the desired sensor input type you intend to calibrate. Additionally, make sure you write your selections to the transmitter by clicking the [Send I/O Config] button.

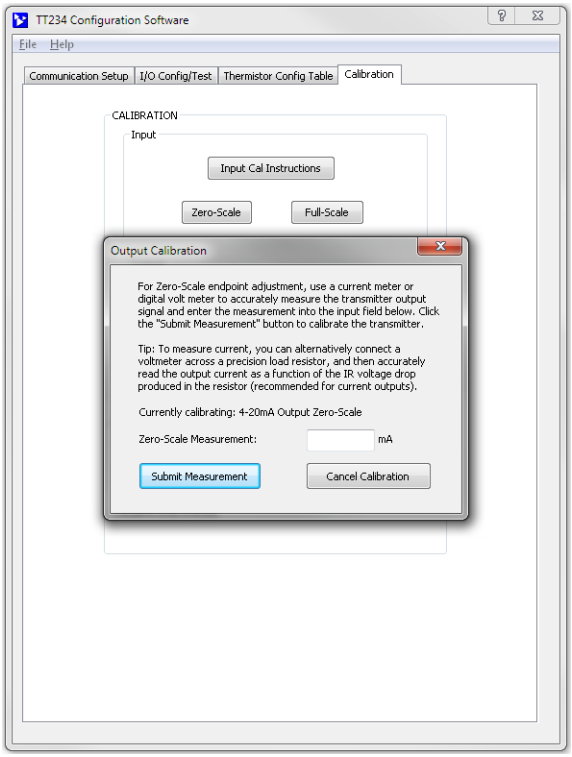
Click the **[Input Cal Instructions]** button to begin input calibration and enable the Input [Zero-Scale] and [Full-Scale] buttons.

Click the Input **[Zero-Scale]** button of the Calibration Input section. You will be prompted to input the zero-scale resistance at TB1/TB2 for Thermistor/Rheostat input types, or connect input pins 3 & 2 for Potentiometer input types. Once you input the zero precisely or connect the input pins, click the **[OK]** button of the prompt to calibrate zero-scale.

Click the Input **[Full-Scale]** button of the Calibration Input section. You will be prompted to input the zero-scale resistance at TB1/TB2 for Thermistor/Rheostat input types, or connect input pins 3 & 4 for Potentiometer input types. Once you input the zero precisely or connect the input pins, click the **[OK]** button of the prompt to calibrate zero-scale.

CAUTION – Input Calibration: Driving inputs outside of the nominal input range of the transmitter will not be acceptable for calibration of zero or full-scale. Since input levels cannot be validated during calibration, incorrect signal levels will produce an undesired output response.

Calibration (Optional)...


TT234 Configuration Software
File Help
Communication Setup
I/O Config/Test
Thermistor Config Table
Calibration
CALIBRATION
Input
Input Cal Instructions
Zero-Scale
Full-Scale
Output Calibration
For Zero-Scale endpoint adjustment, use a current meter or digital volt meter to accurately measure the transmitter output signal and enter the measurement into the input field below. Click the "Submit Measurement" button to calibrate the transmitter.
Tip: To measure current, you can alternatively connect a voltmeter across a precision load resistor, and then accurately read the output current as a function of the IR voltage drop produced in the resistor (recommended for current outputs).
Currently calibrating: 4-20mA Output Zero-Scale
Zero-Scale Measurement:
mA
Submit Measurement
Cancel Calibration

Calibration – Output

Before attempting to recalibrate the output channel, make sure you write your selections to the transmitter by clicking the [Send I/O Config] button.

Click the **[Output Cal Instructions]** button to begin output calibration and enable the Output [Zero-Scale] and [Full-Scale] buttons.

For output zero-scale endpoint adjustment, click the **[Zero-Scale]** button to open the zero-scale configuration popup. Use a current meter or digital volt meter to accurately measure the transmitter output signal and enter the measurement in the input field provided. Click the **[Submit Measurement]** button to send the calibration to the transmitter.

For output full-scale endpoint adjustment, click the **[Full-Scale]** button to open the full-scale configuration popup. Use a current meter or digital volt meter to accurately measure the transmitter output signal and enter the measurement in the input field provided. Click the **[Submit Measurement]** button to send the calibration to the transmitter.

If your output acts erratic or appears imprecise, you may need to repeat input or output calibration, being very careful to take accurate measurements and input correct signal levels. If you are measuring a voltage across a load resistance, make sure that you use the exact resistance when calculating the load current being measured. Also, when rescaling to a smaller sub-range, make sure that you have adequate input span. Input spans that are too small will have diminished resolution and will magnify error.

Factory Settings

The **[Restore Factory Calibration]** button resets transmitter and causes it to revert to its factory calibration without effecting user configuration. Useful if there was an error during recalibration that degraded performance or the I/O channel appears erratic.

The **[Restore Factory Default]** button restores a transmitter to its original factory state (See Specifications Reference Test Conditions). This includes calibration and configuration. This control can be used as a sanitation tool to restore the transmitter to its initial configuration.

Calibration Status

This field displays calibration status messages such as “No Error”, “No Device Connected”, “Calibration Error”, “Transfer Error”, and “Timeout Error” during calibration. If you encounter an error, you may have to repeat the calibration process.

Thermistor Resistance versus Temperature

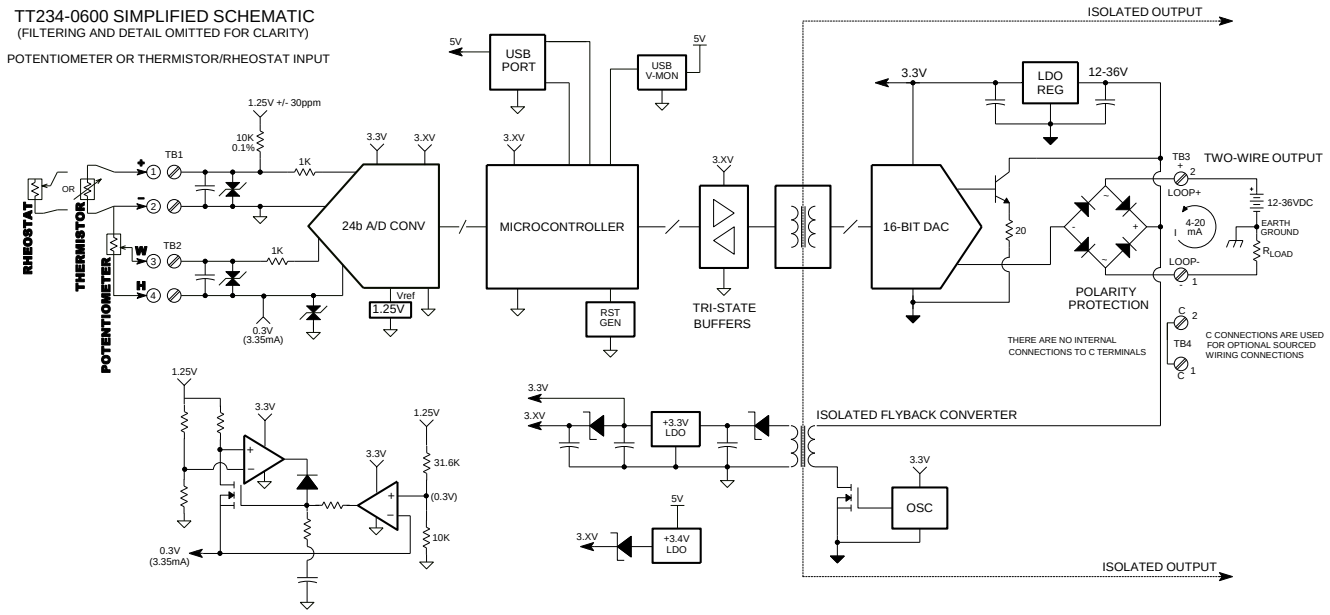
	Temperature in Ohms						
TEMP °C	R_{25} = 2252Ω $\beta_{25/85}$ = 3978	R_{25} = 2795Ω $\beta_{25/85}$ = 4076	R_{25} = 2752Ω $\beta_{25/85}$ = 4074	R_{25} = 3000Ω $\beta_{25/85}$ = 3976	R_{25} = 5000Ω $\beta_{25/85}$ = 3920	R_{25} = 10KΩ $\beta_{25/85}$ = 3694	R_{25} = 30KΩ $\beta_{25/85}$ = 3943
–40	75790.0	100865.0	99326.0	101000.0	168300.0	239800.0	884600.0
–35	54660.0	72437.0	71332.0	72810.0	121400.0	179200.0	649300.0
–30	39860.0	52594.0	51791.0	53100.0	88530.0	135200.0	481000.0
–25	29380.0	38583.0	37994.0	39130.0	65240.0	102900.0	359600.0
–20	21870.0	28582.0	28146.0	29130.0	48560.0	78910.0	271200.0
–15	16430.0	21371.0	21044.0	21890.0	36490.0	61020.0	206200.0
–10	12460.0	16120.0	15873.0	16600.0	27670.0	47540.0	158000.0
–5	9534.0	12261.0	12073.0	12700.0	21170.0	37310.0	122100.0
0	7355.0	9399.0	9256.0	9796.0	16330.0	29490.0	94980.0
+5	5719.0	7263.0	7153.0	7618.0	12700.0	23460.0	74440.0
+10	4482.0	5658.0	5572.0	5971.0	9951.0	18790.0	58750.0
+15	3539.0	4441.0	4373.0	4714.0	7857.0	15130.0	46670.0
+20	2814.0	3511.0	3457.0	3748.0	6247.0	12260.0	37300.0
+25	2252.0	2795.0	2752.0	3000.0	5000.0	10000.0	30000.0
+30	1815.0	2240.0	2205.0	2417.0	4029.0	8194.0	24270.0
+35	1471.0	1806.0	1778.0	1959.0	3266.0	6752.0	19740.0
+40	1200.0	1465.0	1443.0	1597.2	2663.0	5592.0	16150.0
+45	983.8	1195.0	1177.0	1310.0	2184.0	4655.0	13280.0
+50	811.3	980.0	965.0	1081.0	1801.0	3893.0	10970.0
+55	672.5	809.0	796.0	895.8	1493.0	3270.0	9109.0
+60	560.3	671.0	660.0	746.3	1243.9	2760.0	7599.0
+65	468.8	559.0	551.0	624.7	1041.0	2339.0	6367.0
+70	394.1	469.0	462.0	525.4	875.7	1990.0	5359.0
+75	332.9	395.0	389.0	443.9	740.0	1700.0	4529.0
+80	282.5	334.0	329.0	376.7	628.1	1458.0	3843.0
+85	240.8	283.0	279.0	321.1	535.4	1255.0	3273.0
+90	206.1	241.8	238.1	274.9	458.2	1084.0	2799.0
+95	177.1	207.1	203.9	236.3	393.7	939.3	2402.0
+100	152.8	178.0	175.3	203.8	339.6	816.8	2069.0
+105	132.2	153.6	151.3	176.4	294.0	712.6	1788.0
+110	115.0	133.1	131.0	153.2	255.4	623.5	1550.0
+115	100.2	115.7	113.9	133.6	228.7	547.3	1348.0
+120	87.7	100.9	99.4	116.8	194.7	481.8	1176.0
+125	77.0	88.3	87.0	102.5	170.8	425.3	1029.0
+130	67.8	77.5	76.4	90.2	150.3	376.4	903.0
+135	59.8	68.3	67.3	79.6	132.6	334.0	794.6
+140	53.0	60.3	59.4	70.4	117.4	297.2	701.2
+145	47.0	53.4	52.6	62.5	104.2	265.1	620.3
+150	41.9	47.5	46.7	55.6	92.7	237.0	550.2

Beta (β) is an indication of the slope of the curve which represents the relationship between the resistance and the temperature of a particular thermistor measured under zero power conditions. The higher the Beta value the greater the change in resistance per degree C. Beta can be calculated as follows:

$$\beta_{T_1/T_2} = \frac{T_1 T_2}{T_2 - T_1} \ln \frac{R_{T1}}{R_{T2}} \qquad \beta_{25/85} = \frac{(298.15)(358.15)}{358.15 - 298.15} \ln \frac{2252.0}{240.8} = 3978.73$$

NOTE: T_1 and T_2 must be converted to degrees Kelvin (°K) before using in the formula above.

BLOCK DIAGRAM



How It Works

Key Points of Operation

- Loop Powered
- Input is Isolated from Output
- Input circuit is common to USB ground
- USB powers a portion of the input circuit when connected, but not the output

The TT234 transmitter uses a 32-bit microcontroller and a high-resolution 24-bit ADC to digitize the input signal and communicate to the output DAC via a serial digital pulse stream. The digital communication stream is isolated via a pulse transformer and is received by the 16-bit output DAC which drives a 4–20mA process current. Power for the isolated input side of the circuit is provided via an isolated flyback converter that operates in parallel with the output loop. Setup involves selecting the input type, selecting a filter level, and scaling the input range endpoints to 4mA and 20mA at the output. Output scaling can also be done in reverse to produce a reverse acting output signal. The maximum over-range output signal is approximately 24mA, the under-range signal is 3.5mA. Refer to the block diagram above to gain a better understanding of how this transmitter works.

The input/USB, output/power circuits are isolated from each other. The USB port ground is common to the input circuit ground. The USB port ground of most PC's is also common to the USB cable shield and earth ground. Input sensors could be grounded or ungrounded. For this reason, it is recommended that USB signals be isolated when connected to a PC to prevent a ground loop from occurring between the PC earth ground and a grounded input sensor, which would have the negative affect of pulling the input bias supply to ground, clipping the negative portion of the bipolar input range.

TROUBLESHOOTING

Diagnostics Table

Before attempting repair or replacement, be sure that all installation and configuration procedures have been followed and that the transmitter is wired properly. Verify that power is applied to the transmitter and that the supply voltage is at least 11V.

If the problem still exists after checking the wiring and reviewing this information, or if other evidence points to another problem with the transmitter, an effective and convenient fault diagnosis method is to exchange the questionable transmitter with a known good transmitter.

Acromag's Application Engineers can provide further technical assistance if required. Repair services are also available from Acromag.

POSSIBLE CAUSE	POSSIBLE FIX
Cannot Communicate with Transmitter via USB…	
Output shifts off-range when connect USB is connected…	
Output Erratic, Not operational, or at Wrong Value…	
Transmitter fails to operate or exhibits an output shift…	
A missing USB Isolator could cause a ground loop between a grounded input sensor and earth ground at the connected PC's USB port.	Without a USB isolator, a ground loop is possible between a grounded input signal source and earth ground of the PC USB port. It is best to connect to USB via a USB isolator for this reason, and for increased safety and noise immunity. Use an isolator like the Acromag USB-ISOLATOR. Otherwise, use a battery powered laptop to configure the transmitter which does not normally earth ground its USB port.
Software Fails to Detect Transmitter…	
Bad USB Connection	Recheck USB Cable Connection
USB has not enumerated the transmitter.	Use the reset button on the Acromag USB isolator to trigger re-enumeration of the transmitter, or simply unplug/re-plug the USB cable to the transmitter.
Communication or power was interrupted while USB was connected with the configuration software running.	Close the current connection with the software, select and re-open the transmitter for communication (or simply exit the configuration software and restart it).
For an input step, the output appears to make 2 steps to reach its final value…	
For a step change in the input, the ADC requires 2 input samples to fully characterize the input signal.	The ADC requires two samples to fully characterize the input signal, and this is evident when using a scope to examine the output transition in response to a step change at the input, which makes two steps in its transition to its final level.
Output goes to Over-Range (24mA) or Under-Range Limit (3.5mA)…	
This indicates that either the input signal is out of range, or a sensor lead has broken. It can also occur due to contention between earth ground at the PC USB port and the input sensor.	Check the input signal with respect to its range and reduce or increase it as required to drive the output within its linear operating range. A fully Over-Range or Under-Range signal can be driven by a sensor fault, such as an open or broken sensor lead. If USB is not isolated, check for a ground loop between a grounded sensor and earth ground of the PC USB port.

Diagnostics Table…

POSSIBLE CAUSE	POSSIBLE FIX
Cannot Calibrate Input Channel…	
Is input wired properly?	Check that input is wired to ± input terminals using correct polarity.
Cannot Measure Input Temperature or Resistance…	
Input may be wired incorrectly to the input terminals.	Verify that the sensor or resistance decade box is wired to the transmitter correctly. Refer to Sensor Input Connections for wiring sensors to the transmitter.

Service & Repair Assistance

This transmitter contains solid-state components and requires no maintenance, except for periodic cleaning and transmitter calibration and verification (zero and full-scale). Its enclosure is not meant to be opened for access and can be damaged easily if snapped apart. It is highly recommended that a non-functioning transmitter be returned to Acromag for repair or replacement. Acromag has automated test equipment that thoroughly checks and calibrates the performance of each transmitter, and can restore firmware. Please refer to Acromag's Service Policy and Warranty Bulletins, or contact Acromag for complete details on how to obtain repair or replacement.

ACCESSORIES

Software Interface Package

Software Interface Package/Configuration Kit – Order TTC-SIP

- USB Signal Isolator
- USB A-B Cable 4001-112
- USB A-mini B Cable 4001-113
- Configuration Software CDROM 5040-944

This kit contains all the essential elements for configuring TT230 & TT330 family Transmitters. Isolation is recommended for USB port connections to these transmitters and will block a potential ground loop between the PC and a grounded current loop. A software CDROM is included that contains the Windows software used to program the transmitter.

USB Isolator

USB Isolator – Order USB-ISOLATOR

- USB Signal Isolator
- USB A-B Cable 4001-112
- Instructions 8500-900

This kit contains a USB isolator and a 1 meter USB A-B cable for connection to a PC. This isolator and cable are also included in TTC-SIP (see above).

USB A-B Cable

USB A-B Cable – Order 4001-112

- USB A-B Cable 4001-112

This is a 1 meter, USB A-B replacement cable for connection between a PC and the USB isolator. It is normally included with the TTC-SIP Software Interface Package and also with the isolator model USB-ISOLATOR.

USB A-mini B Cable

USB A-mini B Cable – Order 4001-113

- USB A-mini B Cable 4001-113

This is a 1 meter, USB A-miniB replacement cable for connection between the USB isolator and the transmitter. It is normally included in the TTC-SIP.

Note that software for all TT Series models is available free of charge, online at www.acromag.com.

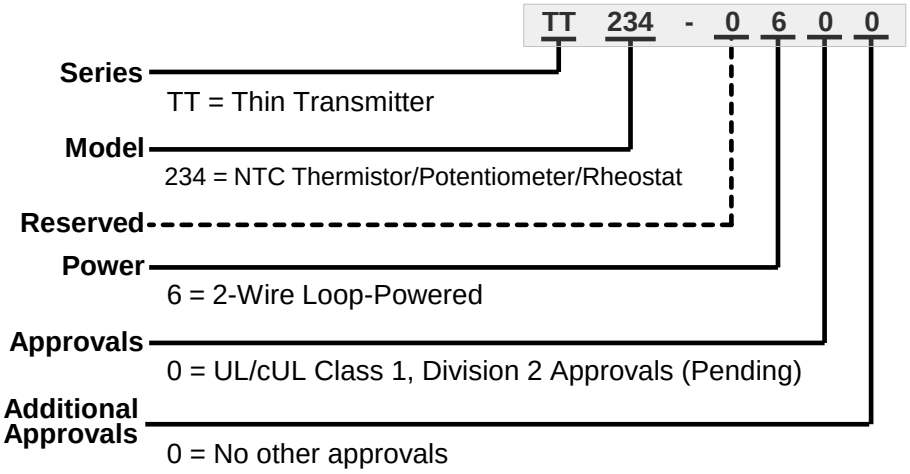
SPECIFICATIONS

Model Number

Model TT234-0600

- Signal Transmitter
- Isolated Thermistor, Rheostat, and Potentiometer Input
- Two-Wire Powered
- CE Approved
- Includes UL/cUL Class 1, Division 2 approvals

Custom calibration to customer specifications can be added as a separate line item at time of purchase.



Optional factory calibration to customer specifications is ordered as a separate line item at time of purchase, and on a per unit basis. Factory calibration will require the specification of input type, input range zero, input range full-scale, Steinhart-Hart or Beta constants for Thermistor input types, and output range. Normal or reverse acting output and a filter level can also be specified. Use form 8500-858 for specifying this calibration from our web site at www.acromag.com.

The standard model without adding custom factory calibration is calibrated by default to reference test conditions. Recalibration of any transmitter will require use of a TTC-SIP configuration kit, ordered separately (see Accessories section). Modules can be mounted on standard 35mm "T" Type DIN rail.

Input

Input Reference Test Conditions: Potentiometer/Slidewire; 0% to 100% input; Filtering = Medium; Output = 4 to 20mA ascending; R-Load = 250Ω. Ambient = 25°C; Power supply = 24VDC;

Input Excitation Voltage: Thermistor/Rheostat: Set to 1.25V DC with less than 30ppm/°C drift over temperature, current limited to 0.125mA, typical. Potentiometer: Set to 0.3V DC, current limited to 3.35mA, typical.

Input Overvoltage Protection: Bipolar Transient Voltage Suppressors (TVS) rated up to 5.6V working voltage, typical. Also includes capacitive filtering, and series resistance.

Input Filtering: Normal mode RC filtering, plus digital filtering, optimized and fixed per input range and filter selection within the Σ-Δ ADC. See Normal Mode Noise Rejection and Output Response Time.

Input Response Time: See output response time.

Input Linearization (NTC Thermistor Inputs Only): Uses Thermistor Config Table (Configured using software).

Input Impedance: Thermistor/Rheostat: 200MΩ, typical. Potentiometer: 15.4MΩ, typical.

Input…

Analog to Digital Converter (ADC): Input utilizes a 24-bit, Σ-Δ ADC converter, with only the first 16-bits used. (see Input Resolution below).

Input Resolution & Accuracy:

The ADC of this model divides the input signal range into a number of parts that can be calculated using the expression for ADC counts as: 32768 * Rin / (10000 + Rin), with Rin = Input Resistance in Ohms, for Thermistor/Rheostat input types. Potentiometer input types have a fixed input resolution of 32768 due to a ratiometric measurement technique. An indication of nominal input resolution is expressed as the number of parts between the input range low and high endpoints.

Table 1 – Input Measurement Accuracy Per Input Type

Input Type	Input Range	Typical Accuracy[1]
Potentiometer	0% to 100% $\left(\begin{matrix}Any\ Potentiometer \\ 100\Omega\ to\ 100K\Omega\end{matrix}\right)$	±0.1% of Span
Rheostat	100Ω to 500KΩ	±0.75% of Input Resistance
NTC Thermistor 2252Ω	–40°C to 100°C	±0.1°C (±0.18°F)
NTC Thermistor 2752Ω	–40°C to 100°C	±0.1°C (±0.18°F)
NTC Thermistor 2795Ω	–40°C to 100°C	±0.1°C (±0.18°F)
NTC Thermistor 3KΩ	–40°C to 100°C	±0.1°C (±0.18°F)
NTC Thermistor 5KΩ	–40°C to 100°C	±0.1°C (±0.18°F)
NTC Thermistor 10KΩ	–40°C to 100°C	±0.1°C (±0.18°F)
NTC Thermistor 30KΩ	–30°C to 100°C	±0.1°C (±0.18°F)
	–40°C to 100°C	±0.5°C (±0.90°F)
Custom NTC Thermistor	100Ω to 500KΩ	±0.5% of Input Resistance[2]

Notes (Table 1):

[1] Thermistor/Rheostat: Accuracy is based on a sensor lead wire resistance of 0Ω.

[2] To determine the Typical Accuracy in terms of temperature for custom thermistor input types, use the following equation. For a Thermistor with input resistance R_{TH}: Typical Temp. Accuracy = ±{(Thermistor Temp. at [R_{TH}]) – (Thermistor Temp. at [R_{TH} + R_{TH}*Typical Accuracy])}

This transmitter allows a portion of the nominal input range to be rescaled to the output range selected. However, the effective input resolution will be proportionally diminished as the input range span is reduced below its nominal span. The effective I/O resolution of this transmitter will be the lowest resolution of the ADC itself or the output DAC (output DAC is 1 part in 43690 for 4-20mA).

Sampling Rate (ADC): Input is sampled at a variable rate according to the input filter selection as follows:

ADC Sampling rate (Samples/Second) per Input Filter

None	Low	Medium	High
214.65sps	53.6625sps	13.42sps	1.6775sps

Input Zero and Full-Scale Adjustment: Nominal input ranges are selectable and range endpoints are adjustable over the full range of input temperature/resistance. Input Zero and Full-Scale selections must be within the nominal range and will be mapped to 0% and 100% at the output. Keep in mind that the input resolution diminishes below nominal as the programmed input range is reduced. Likewise, error is magnified as the input span is reduced.

Input Lead Resistance Effect: For Thermistor/Rheostat Input Types. Shift less than ±0.01% per ohm of lead resistance, with a max shift less than ±0.1% with up to 10Ω per ±lead (with Input Span ≥ 25KΩ).

Lead Break/Sensor Burnout Detection: For Thermistor/Rheostat Input Types. Can be set for Over-range or Under-range open sensor or lead break detection. Over-range output limit is approximately 24mA. Under-range limit is approximately 3.5mA.

Noise Rejection (Common Mode): Varies with input and input filter selection between 89dB (no filter) and 124dB (high filter), typical with 100Ω input unbalance.

Noise Rejection (Normal Mode): Varies with input and input filter selection. Table below indicates the typical rejection at 60Hz for each input and input filter selection. Note that at the medium and high filter settings, the ADC converter adds 80dB minimum of rejection for frequencies between 49Hz and 61Hz.

Typical 60Hz Rejection per Input Filter			
None	**Low**	**Medium**	**High**
17dB	34dB	> 80dB	> 80dB

Output

Output Range: 4 to 20mA DC nominal range, with under-range capability down to 3.5mA, and over-range capability up to 24mA. The output signal is linear with respect to the measured temperature or resistance.

Output Accuracy: Accuracy is better than ±0.05% of span, typical (±0.1% maximum), for nominal input spans. Relative accuracy varies with calibrated input and output span. Accuracy includes the combined effects of repeatability, terminal point conformity, and linearization, but does not include sensor error.

Output Response Time: Varies with input filter level for a step change in the input signal (also varies with output load). Note: The ADC requires two samples to fully characterize the input signal (see Input Sampling Rate).

Filter Level	Response Time (Typical)
None	11ms
Low Filter	40ms
Medium Filter	150ms
High Filter	1200ms

Output DAC Resolution: Output DAC is 16-bit and its output current is approximated via the expression (programmed_count/65536)*24mA. The min loop current is ~3.5mA, typical, which is approximated via a DAC program count of 9120. Likewise, 4mA corresponds to a count value of ~10923, and 20mA to ~54613. Thus, for the 4-20mA output range, we have an output resolution of 54613-10923, or 1 part in 43690. The effective I/O resolution of this transmitter will be the lowest resolution of either the input, or the output.

Output Ambient Temperature Drift: Includes the combined effects of zero and space drift over temperature and is better than ±80ppm/°C (±0.0080%/°C) over the ambient temperature range for reference test conditions (see Input Specifications).

Output Ripple/Noise: Less than ±0.1% of output span.

Note (High Speed Acquisition): Additional filtering at the load is recommended for sensitive applications with high-speed acquisition rates. High frequency noise is often reduced or eliminated by placing a 0.1uF capacitor directly across the load. For excessive 60Hz supply ripple with current output, a 1uF or larger bulk capacitor is recommended at the load.

Output Power Supply: This device is output loop powered from 12–32VDC SELV (Safety Extra Low Voltage), 24mA maximum. The supply voltage across the transmitter must never exceed 36V, even with a shorted load. The supply voltage level must be chosen to provide a minimum of full-scale current to the load (0.020*R typical), plus 11V minimum to the transmitter terminals, plus any line drop. Ideally, the supply should drive over-scale current levels up to 24mA into load. Reverse polarity protection is inherent as output terminals are not polarized. The ± output polarity labels on the enclosure are for reference only.

CAUTION: *Do not exceed 36VDC peak to avoid damage to the transmitter. Terminal voltage above 11V minimum must be maintained across the transmitter during operation.*

Output Power Supply Effect: Less than ±0.001% of output span per volt DC of supply change.

Output Compliance and Load Resistance Equation: 11V minimum, transmitter. Transmitter will drive 13V typical to the load with a 24V loop supply and 20mA loop current (650Ω), assuming negligible line drop. Compute R_{load} (Max) = (V_{supply} – 11V)/0.020A for 20mA full-scale output current. Refer to the following table:

V_{supply} Volts	Max R_{load} w/20mA & No Line Drop
12V	50Ω
18V	350Ω
24V	650Ω
32V	1050Ω

Ideally, it should be possible to drive the over-scale current of 24mA to the load and this would yield a maximum load resistance of 540Ω for 24mA of loop current and a 24V loop supply.

Output Load Resistance Effect: Less than ±0.001% of output span for a ±100Ω change in load resistance.

USB Interface

IMPORTANT:

The input of this transmitter is isolated from its output and can be connected to grounded or un-grounded input sensors. However, the transmitter's input circuit ground is connected in common to the USB power/signal/shield ground. This will in-turn make a connection to earth ground at the PC when directly connected to the USB port of a PC without using an isolator. Failure to connect USB without isolation would connect the 1.25V input bias supply to input ground if the sensor is also earth grounded. This will interfere with operation and cause the output to shift. For this reason, USB isolation is strongly recommended when connecting to a PC. Otherwise, in the absence of USB isolation, and when connected to a grounded input sensor, a battery powered laptop could be used to connect to the transmitter, as the laptop does not normally connect to earth ground.

Transmitter includes a USB socket for temporary connection to a PC or laptop for the purpose of setup and reconfiguration. USB isolation is required when connected to a grounded input sensor (see "IMPORTANT" note on the left). During reconfiguration and calibration, the transmitter receives power from both the USB port and the output loop. Both power sources must be present to calibrate the transmitter.

CAUTION: Do not attempt to connect USB in a hazardous environment. Transmitter should be configured and calibrated in a safe environment only.

Data Rate: USB v1.1 full-speed only, at 12Mbps. Up to 32K commands per second. USB 2.0 compatible.

Transient Protection: Transient voltage suppression on USB power and data lines.

Inrush Current Limiting: Includes series inrush current limiting at USB power.

USB Connector: 5-pin, Mini USB B-type socket, Hirose Electric UX60-MB-5S8.

Pin	Definition
1	+5V Power
2	Differential Data (+)
3	Differential Data (-)
4	NC – Not Connected
5[1]	Power Ground (Connects to Signal Ground via ferrite bead)
SHLD[1]	Signal Ground (Connects directly to Signal Ground)

[1]**Note:** Most Host Personal Computers (except battery powered laptops) will connect earth ground to the USB shield and signal ground.

Cable Length/Connection Distance: 5.0 meters maximum.

Driver: No special drivers required. Uses the built-in USB Human Interface Device (HID) drivers of the Windows Operating System (Windows XP or later versions only).

Enclosure & Physical

General purpose plastic enclosure for mounting on 35mm "T-type" DIN rail.

Dimensions: Width = 12.5mm (0.5 inches), Length = 114.5mm (4.51 inches), Depth = 99.0mm (3.90 inches). Refer to Mechanical Dimensions drawing.

I/O Connectors: Removable plug-in type terminal blocks rated for 12A/250V; AWG #26-12, stranded or solid copper wire.

Program Connector: USB Mini B-type, 5-pin. See USB Interface.

Case Material: Self-extinguishing polyamide, UL94 V-0 rated, color light gray. General purpose NEMA Type 1 enclosure.

Circuit Board: Military grade fire-retardant epoxy glass per IPC-4101/98 with humi-seal conformal coating.

DIN-Rail Mounting: Transmitter is normally mounted to 35x15mm, T-type DIN rails. Refer to the DIN Rail Mounting & Removal section for more details.

Shipping Weight: 0.5 pounds (0.22 Kg) packed.

Environmental

These limits represent the minimum requirements of the applicable standard, but this product has typically been tested to comply with higher standards in some cases.

Operating Temperature: -40°C to +80°C (-40°F to +176°F).

Storage Temperature: -40°C to +85°C (-40°F to +185°F).

Relative Humidity: 5 to 95%, non-condensing.

Isolation: Input/USB, output/power circuits are isolated from each other for common-mode voltages up to 250VAC, or 354V DC off DC power ground, on a continuous basis (will withstand 1500VAC dielectric strength test for one minute without breakdown). Complies with test requirements of ANSI/ISA-82.01-1988 for voltage rating specified.

Installation Category: Suitable for installation in a Pollution Degree 2 environment with an Installation Category (Over-voltage Category) II rating per IEC 1010-1 (1990).

Shock & Vibration Immunity: Module rated to 5g Random Vibration, 5-500Hz, in 3 axis at 2 hours/axis per IEC60068-2-64; Mechanical Shock to 50g, 3ms, with 3 half-sine shock pulses in each direction along 3 axis (18 shocks), and 30g, 11ms, with 3 half-sine shock pulses in each direction along 3 axis (18 shocks), per IEC60068-2-27.

Electromagnetic Compatibility (EMC)

Minimum Immunity per BS EN 61000-6-1

1. Electrostatic Discharge Immunity (ESD), per IEC 61000-4-2
2. Radiated Field Immunity (RFI), per IEC 61000-4-3
3. Electrical Fast Transient Immunity (EFT), per IEC 61000-4-4
4. Surge Immunity, per IEC 61000-4-5
5. Conducted RF Immunity (CRFI), per IEC 61000-4-6

Class B Product with Emissions per BS EN 61000-6-3

1. Enclosure Port, per CISPR 16
2. Low Voltage AC Mains Port, per CISPR 14, 16
3. DC Power Port, per CISPR 16
4. Telecom / Network Port, per CISPR 22

Agency Approvals

Safety Approvals: UL Listed (USA & Canada). Hazardous Locations – Class I, Division 2, Groups A, B, C, D. Consult Factory.
Electromagnetic Compatibility (EMC): CE marked, per EMC Directive 2004/108/EC. Consult factory.

Reliability Prediction

MTBF (Mean Time Between Failure): MTBF in hours using MIL-HDBK-217F, FN2. *Per MIL-HDBK-217, Ground Benign, Controlled,* $G_B G_C$

Temp	MTBF (Hours)	MTBF (Years)	Failure Rate (FIT)
25°C	915,550	104.5	1,092
40°C	613,166	70.0	1,631

Configuration Controls

Software Configuration Only via USB
This transmitter drives an analog output current proportional to a sensor input. No switches or potentiometers are used to make adjustments to this transmitter. Its behavior as an isolated signal amplifier/transducer is determined via programmed variables set using a temporary USB connection to a host computer or laptop running a Windows-compatible configuration software program specific to the transmitter model. This software provides the framework for digital control of all configuration and calibration parameters, and this information is stored in non-volatile memory.

Refer to Operation Step-By-Step in the Technical Reference section of this manual for detailed information on available software control of this transmitter.

REVISION HISTORY

The following table details the revision history for this document:

Release Date	Version	EGR/DOC	Description of Revision
11-OCT-2013	A	JMO/KLK	Initial Acromag release
23-OCT-2013	B	JMO/KLK	Added Steinhart-Hart Table Preset
12-NOV-2013	C	JMO/KLK	Added MTBF Reliability Prediction
16-DEC-2013	D	JEB/ARP	Removed P.O. Box from address.
21-FEB-2014	E	CAP/ARP JMO/ARP	• Added cULus Mark to this model (removed pending). • Updated Input Specifications.